REFERENCE MANUAL

FIREBERD™ 6000

Telecommunications Techniques Corporation®

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Electro Rent Corporation

ML10607
Rev. G

FIREBERD 6000

OPERATING MANUAL

February, 1991

This Operating Manual applies to all FIREBERD 6000
Communications Analyzers Incorporating Software Revision G.

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SECTION 1
GENERAL INFORMATION

1.1 DOCUMENT/SECTION SUMMARY

This manual offers detailed information about Telecommunications Techniques Corporation's (TTC's) FIREBERD 6000 Communications Analyzer. It provides a complete instrument reference, including a general instrument description, operating instructions, and product specifications.

Please note that the information in this manual covers the plastic-case FIREBERD 6000, the metal-case FIREBERD MC6000 and the remote-control-only FIREBERD 6000R. Unless otherwise noted, the product name FIREBERD 6000 applies to all three.

Also note that the information in this manual applies to REV. G software, which requires 64K RAM and 512K EPROM in the FIREBERD 6000 mainframe. If, at power-up, the message **RAM EXPANSION NOT INSTALLED** or **ROM EXPANSION NOT INSTALLED** is displayed, call customer service (1-800-638-2049) immediately.

Section 1 provides an overview of the FIREBERD 6000's general features and characteristics.

1.2 INSTRUMENT OVERVIEW

The FIREBERD 6000 (Figure 1-1) is an instrument that analyzes the quality of digital communications. It can be used in a variety of locations, including the central office, technical control center, end-user site, engineering laboratory, and earth station.

The FIREBERD uses digital interfaces to test T1, G.703, DDS, and synchronous/asynchronous circuits and equipment. In addition to its versatility, the FIREBERD is very powerful, combining bit error rate testing with performance, signal, and timing analysis.

1.2.1 Features

Multifunctionality

- Synchronous and asynchronous testing via built-in RS-232 interface.
- CCITT V.35, EIA RS-449, DDS, T1, ISDN, G.703, and G.704 testing via modular interfaces which can be inserted in the FIREBERD 6000's rear panel.
- Transmission of standard and nonstandard clock frequencies from 50 Hz to 15 MHz via a built-in synthesizer.

Test Results

- Complete error analysis, with as many as 50 test results measured simultaneously.
- Dual displays which show any two test results at the same time.

Data Patterns and Messages

- 17 fixed data patterns: MARK only, 1:1, 1:7, 3-IN-24, six DDS-specific stress patterns, and seven T1-specific stress patterns.
- Seven pseudorandom data patterns: 63, 511, 2047, 2^{15}-1, 2^{20}-1, 2^{23}-1, and QRSS.
- Up to three user-programmable patterns of up to 2048 bytes each for acceptance testing, stress testing, or simulating live data.
- Standard FOX message in ASCII-synchronous and four asynchronous character formats: Baudot, BCDIC, ASCII, and EBCDIC.

T1 and G.703 Jitter Analysis

- Generates T1 or G.703/G.704 jitter at a single frequency or automatically sweeps jitter over a range of frequencies. Choose sine, square, ramp, triangle, or external waveform.
- Wideband jitter measurement accurately determines the amount of T1 or G.703 jitter over a 10 Hz to 40 kHz or a 2 Hz to 100 kHz range, respectively.
- Jitter spectrum analyzer measures peak-to-peak jitter in 37 discrete frequency bands at 64 kb/s, 40 discrete frequency bands at 1.544 Mb/s, and 58 discrete frequency bands at 2048 kb/s. An array of jitter masks permit testing against a variety of standards.

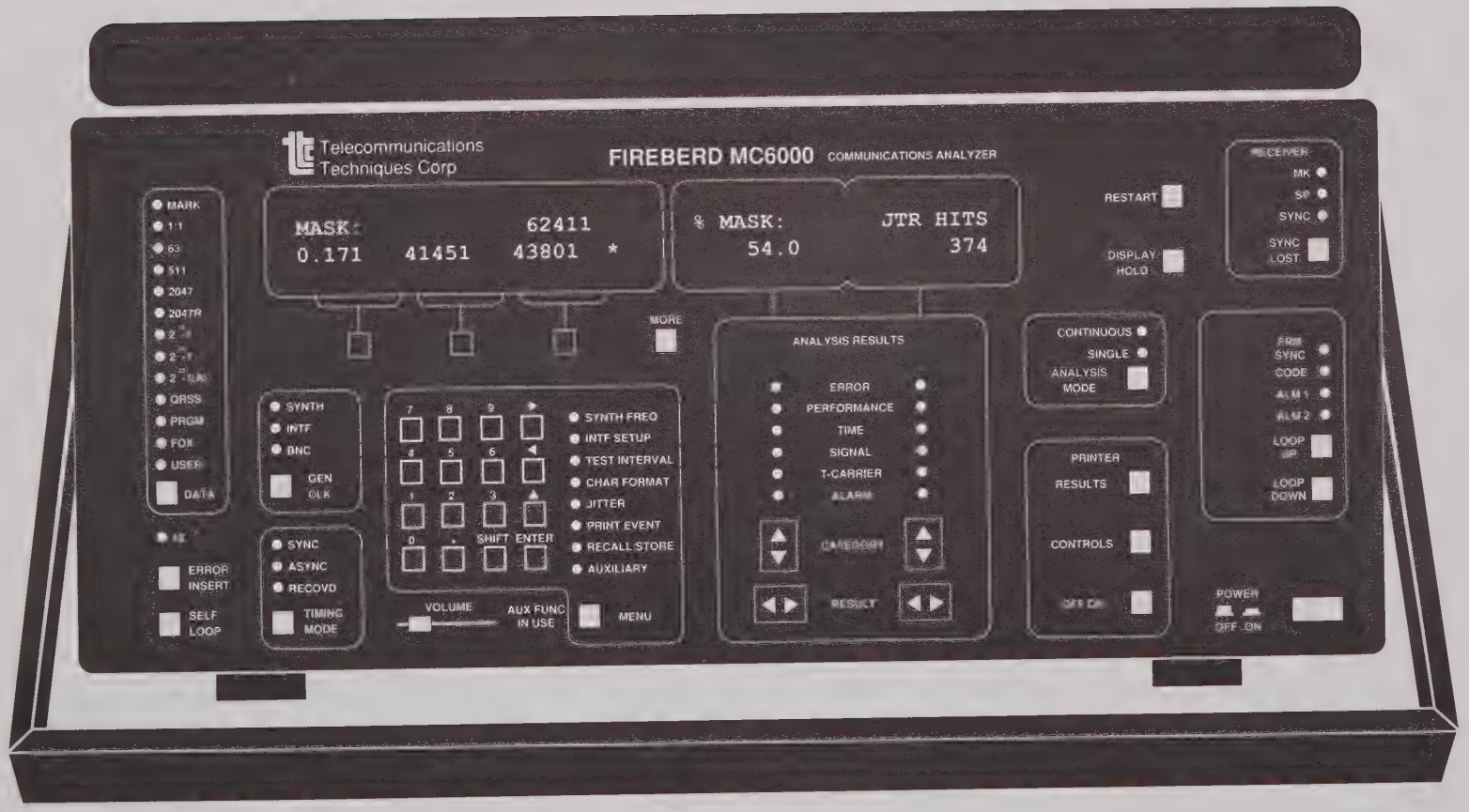


Figure 1-1
The FIREBERD 6000

Full Customization and Programmability

- Programs and stores up to 10 commonly used test scenarios.
- Selectable synchronization loss threshold and response on synchronization loss.
- Programs and stores three long user patterns of up to 2048 bytes each.
- Defines in-band and out-of-band flow control.

Remote Control and Printing Operation

- Supports RS-232 and IEEE-488 printer/remote control interface standards.
- Customized printouts with test results that relate only to your application.

1.2.2 Operating Modes

The FIREBERD 6000 can be used in these modes of operation:

- Emulation of Data Terminal Equipment (DTE), Data Communications Equipment (DCE), or digital transmission test instruments.
- Asynchronous timing using the built-in EIA RS-232 interface, or the modular CCITT V.35, and EIA RS-449 data interfaces.
- Synchronous and recovered timing. Recovered timing is interface-dependent.
- In-service monitoring of live data or out-of-service testing.
- Loopback or end-to-end circuit testing.
- Remote control operation via computer.

1.3 THE FIREBERD'S DIGITAL INTERFACES

Digital interfaces are the key to the FIREBERD 6000's ability to operate in a wide range of telecommunications environments. These interfaces provide the physical connections and signal conversions that allow the instrument to connect, test, and analyze digital circuits and equipment.

The FIREBERD's features and characteristics change based on the current interface selected. Table 1-1 summarizes the interfaces that are available with the FIREBERD 6000.

Table 1-1
FIREBERD 6000 Data Interfaces

Model Number	Manual Number	Interface Label	Description
30608	ML10898	64G703	CCITT G.703 64 kb/s Data Interface — Meets CCITT Recommendation G.703 for testing either co-directional or contra-directional communications equipment operating at 64 kb/s.
30609	ML10899	2MG704	CCITT G.704 2048 kb/s Data Interface — Meets CCITT Recommendation G.703 and G.704 for testing communications equipment operating at 2048 kb/s.
30524	ML10706	8MG703	CCITT G.703 8448 kb/s Data Interface — Meets CCITT Recommendation G.703 for testing communications equipment operating at 8448 kb/s.
41131	ML11319	DDS	DDS LOCAL LOOP Interface meets requirements for testing Digital Data Service (DDS) equipment connections to the local loop. Tests at rates from 2.4 to 56 kb/s with secondary channel capability.
30678	ML11033	DS0A/B	DDS DS0A/DS0B Data Interface — Meets Bellcore and AT&T requirements for DDS testing at DS0 (64 kb/s), DS0A (2.4, 4.8, 9.6, 19.2, and 56 kb/s), and DS0B (2.4, 4.8, and 9.6 kb/s) data rates over all DDS circuits.

Table 1-1
FIREBERD 6000 Data Interfaces

Model Number	Manual Number	Interface Label	Description
30481	ML10633	DS0	DDS DS0/DS0A Data Interface—Meets Bellcore and AT&T requirements for DDS testing at DS0 (64 kb/s) and DS0A (2.4, 4.8, 9.6, and 56 kb/s) data rates.
41440	ML11668	DS1/T1/FT1	T1/FT1 Data Interface—Meets AT&T, Bellcore, and CCITT specifications for T1 (DS1) 1.544 Mb/s and fractional T1.
40540	ML11035	DS1/T1	DS1/T1/D4/ESF/SLC-96 Data Interface — Meets AT&T, Bellcore, and CCITT specifications for T1 (DS1), AT&T PUB54016 specifications for Extended Superframe (ESF), and AT&T specifications for Subscriber Loop Carrier (SLC) circuits.
30447A	ML10980	DS1C/2	DS1C/DS2 Data Interface — Meets AT&T and Bellcore DSX-1C, DSX-2, or DS2H interface specifications for testing data communications systems operating at DS1C (3152 kb/s) and DS2 (6312 kb/s) data rates.
41075	ML11256	ISDN	ISDN S/T TE Data Interface—Meets ANSI and CCITT standards for the ISDN S and T reference points.
40204	ML11037	LAB	LAB (TTL) Data Interface—Tests a variety of data handling devices, with BNC connections for received data and clock inputs, transmit data and clock outputs, and an external transmit clock input operating from 50 Hz to 15 MHz, with bipolar or unipolar balanced or unbalanced data. This interface can also control the clock and data phasing and match a variety of input and output impedances.
40298	ML10511	MILBAL	MIL188-114 Balanced Data Interface — Meets MIL-STD-118-114 bipolar balanced specifications.
40226	ML11267	MILUNB	MIL188C/MIL118-114 Unbalanced Data Inteface — Meets MIL-STD-118-114 bipolar unbalanced and MIL-STD-188C specifications.
—	ML10607	INT232	Internal RS-232-C Data Interface — Meets EIA-RS-232-C specification for testing synchronous and asynchronous circuits, to 64 kb/s and 20 kb/s, respectively. This interface is built into the FIREBERD 6000 mainframe. See Section 8 for a complete description.
41400	ML11623	RS-449/MIL	RS-449/MIL Data Interface — Meets EIA RS-449/RS-530/RS-422/RS-MIL 423, MIL-STD-188-114, and MIL-STD-188C specifications. This interface can be configured as a DTE or a DCE device through the interface set-up menu. A crossover cable is not required.
40200	ML11032	RS-449	RS-449 (422/423) DTE/DCE Data Interface - Meets EIA RS-449, EIA-422, and EIA RS-423 standards and CCITT Recommendations V.10 and V.11. This interface offers 3 modes of operation: RS-423/V.10 (unbalanced), RS-422/V.11 (balanced) terminated, and RS-422/V.11 (balanced) unterminated.
40202	ML11031	V.35	V.35/306 DTE/DCE Data Interface — Meets CCITT V.35 Recommendation and AT&T PUB41304 for 306-type wideband data sets and PUB41450 for DDS Data Service Unit (DSU) specifications.
40182	ML11038	WEC303	WECO 303 Data Interface — Meets AT&T PUB41302 specifications for testing 303-type wideband data stations.

SECTION 2
PREPARATION FOR USE

2.1 SECTION SUMMARY

This section describes how to prepare the FIREBERD 6000 for initial use. It offers procedures for unpacking, inspection, and safety, as well as power requirements and instrument checkout.

2.2 UNPACKING AND INITIAL INSPECTION

The shipping container should be inspected for damage when it is received. If the shipping container or shipping material is damaged, keep it until the contents of the shipment have been checked for completeness and the unit has been checked mechanically and electrically. Procedures for checking electrical performance are given in Section 2.8, Instrument Checkout. The customer should notify TTC if the contents are incomplete, if there is mechanical damage or defect, or if the FIREBERD does not pass the instrument checkout procedure described in Section 2.8. If the shipping container is damaged, notify the carrier and TTC, and keep the shipping container and materials for the carrier's inspection. Should repairs be necessary, follow the instructions in Section 12, Maintenance and Service, for returning the unit to TTC.

2.3 INSTRUMENT IDENTIFICATION

An identification sticker is attached to the rear panel of each FIREBERD 6000. The sticker bears the serial number assigned to the unit. Any factory-installed options are also listed by option number on the rear panel. Quote the serial number and options on any correspondence with TTC concerning the unit.

2.4 EQUIPMENT INCLUDED

The following equipment is supplied with each unit:

- Power cord
- Operating manuals
- Front cover
- Snap-on back pouch

2.5 WARNINGS

The following precautions must be observed before and during all phases of operation. Failure to comply with these precautions or specific warnings elsewhere in the manual can cause physical harm to the operator or damage to the unit. TTC assumes no liability for the customer's failure to comply with these requirements.

GROUND THE INSTRUMENT

To minimize shock hazard, connect the instrument chassis to an electrical ground. The instrument is equipped with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

USE PROPER LINE VOLTAGE SETTING AND FUSE SIZE

Before connecting the AC power cord, verify that the line voltage selector module is positioned for the correct operating voltage. Do not operate the instrument with the incorrect fuse size.

KEEP AWAY FROM LIVE CIRCUITS

Do not remove covers or insert fingers or other objects through the rear panel holes while power is applied to the instrument.

TURN OFF POWER BEFORE INSERTING OR REMOVING INTERFACE MODULES

Damage can result if any modular interface is inserted into the FIREBERD 6000 when power is applied to the instrument.

DO NOT OPERATE IN AN AMBIENT TEMPERATURE ABOVE 50°C

2.6 POWER REQUIREMENTS

The FIREBERD 6000 requires a power source of 90-135 or 195-250 VAC, single phase, 48 to 66 Hz that can deliver 120 volt-amperes (maximum). When shipped from the factory, the instrument is normally set to operate from a 120-volt power source. To operate the instrument from a different source voltage, do the following:

1. Remove the input power cord.
2. Slide the plastic door on the AC input connector to the left.
3. Remove the fuse.
4. Pull the voltage select module straight out.
5. Change the orientation of the voltage select module and reinsert it so the appropriate operating voltage is visible on the card after it has been installed.
6. Install the appropriate fuse rating (See Table 2-1).
7. Slide the plastic door to the right and reinsert the power cord.

Table 2-1
Fuse Rating

Operating Voltage:	Fuse Rating:
90-135	3 amp 125 V Slow Blow
195-250	1.5 amp 250 V Slow Blow

2.7 GROUND JUMPER

All FIREBERD 6000s are equipped with a pluggable ground jumper. When shipped from the factory, signal ground is connected to chassis ground through a 100-ohm, 1/2 watt resistor. Alternatively, signal ground may be directly connected to chassis ground by repositioning the pluggable jumper on a PC board. To reposition the jumper, use either of the following procedures, as applicable.

2.7.1 FIREBERD 6000/6000R (Plastic Case)

1. Remove the power cord from the FIREBERD.
2. Turn the unit upside down and remove the four screws from the bottom of the plastic case.
3. Turn the unit right side up and remove the top cover by pressing on both its sides and pulling up.
4. Locate PC board #40442 immediately behind the front panel. The pluggable ground jumper is located on the upper left corner of the component side of the board (Figure 2-1).
5. Lift the jumper (JW1) from the three-position header (B position) and place it one position to the right (A position).
6. Put the top cover back into place, turn the unit upside down, and secure the cover by refastening the four screws to the bottom of the case.

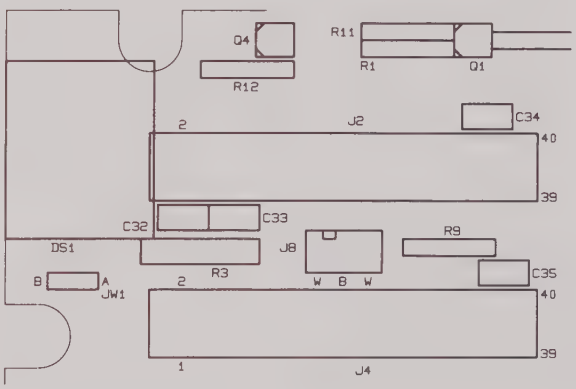


Figure 2-1
Component Side PC Board #40442
View of Upper Left Corner
and Pluggable Jumper Position

2.7.2 FIREBERD MC6000 (Metal Case)

1. Remove the power cord from the FIREBERD.
2. Locate and remove the two screws (one on each side of the case) which secure the front bezel.

   NOTE: If the case is equipped with a handle, press the buttons on each side and rotate it downward; the front bezel screws (one on each side of the case) are now exposed.

3. Remove the front bezel by pulling forward.
4. Slide the top cover forward and lift out.

5. Locate PC board #40442 immediately behind the front panel. The pluggable ground jumper is located on the upper left corner of the component side of the board (see Figure 2-1).

6. Remove the pluggable jumper (JW1) from the three-position header (B position) and install it one position to the right (A position).

7. Replace the top cover by sliding it through the guides on each side of the case. Ensure that the cover is seated properly in the rear of the FIREBERD.

8. Press the front bezel back in place and replace the two screws.

2.8 INSTRUMENT CHECKOUT

This section describes the automatic self-test that the FIREBERD 6000 performs at power-up. Also described is a manual self-test which can be used to verify proper operation of the instrument. The following procedures assume that the user is familiar with the operation of the FIREBERD 6000; users who are unfamiliar with the instrument's operation should refer to Sections 3 and 4 of this manual.

2.8.1 Automatic Self-Test

The automatic self-test is a series of diagnostic tests that are performed by the FIREBERD 6000 at power-up. These tests ensure that the instrument is functioning correctly. If any of these tests fail, the FIREBERD 6000 displays a message identifying the failed component.

During the automatic self-test:

- All discrete LEDs (except the MK and SP indicators), switches containing LEDs, and backlit panel labels are illuminated, and the software revision and date appear in the left display.

- All memory is tested. If an error is found, a message is displayed. If an EPROM error message appears, the unit may not operate. Call TTC for service.

- Switch positions are checked. If a switch is pressed or stuck during power-up, an error message identifies it. For example, holding down the DATA switch causes the message KEY STUCK DATA to be displayed for approximately 1 second. In such instances, the switch is not operational.

- Non-volatile RAM (NOVRAM) is checked to restore the switch settings that were in effect when the unit was last shut off. If any changes are detected, a message specifies what general portion of NOVRAM failed, and the original factory settings are automatically restored for the affected portions of NOVRAM. Note that the FIREBERD 6000 may still be fully operational even though switch settings are not saved during a power cycle.

2.8.2 Manual Self-Test

Manual self-tests ensure that the individual components of the FIREBERD 6000 are working properly. TTC recommends the use of the built-in RS-232/V.24 interface for this test. If, however, the RS-232 interface is not operating, a modular interface can be substituted. Section 8 describes the set-up procedure for the RS-232/V.24 interface; refer to the appropriate manual (Section 1) for information on modular interface set-up.

REMINDER: Turn the FIREBERD 6000 OFF before inserting or removing any modular interface.

Before beginning any manual self-test procedure, verify that:

- The automatic self-test is successful.

- The ac line voltage card is set properly.

- If required, the modular interface is properly installed.

- The power to the unit is ON.

The following self-test procedures can be performed in sequential order or individually as required:

- Frequency synthesizer and frequency counter self-test.

- Synchronous transmit and receive self-test.

- Error counter and error insert self-test.

- Seconds and blocks self-test.

- Data generator self-test.

NOTE: If any self-test indicates that the instrument requires service, please note the areas of the test in which the FIREBERD 6000 failed prior to contacting TTC for assistance.

2.8.2.1 Frequency Synthesizer and Frequency Counter Self-Test

To test the FIREBERD 6000's frequency synthesizer and the frequency counter, do the following:

1. Press the SELF LOOP switch to enter Self-Loop mode. Make sure that the switch is illuminated.
2. Set the DATA switch to the 2^{23}-1 position.
3. Set the GEN CLK switch to the SYNTH position.
4. Set the TIMING MODE switch to the SYNC position.
5. Set the MENU switch to the INTF SETUP position.

   RESULT: An interface selection menu appears in the display immediately above the keypad.
6. Press the softkey beneath INT232.
7. Press the EMLATE softkey.
8. Press the DTE softkey.

   RESULT: Interface set-up is complete.
9. Set the MENU switch to the SYNTH FREQ category.
10. Press the illuminated MORE key until 64 appears as a softkey selection.
11. Press the 64 softkey to set the synthesizer frequency to 64 kHz.
12. In the ANALYSIS RESULTS area, set the left and right CATEGORY switches to the SIGNAL position.
13. Press the right RESULT switch until RCV FREQ appears in the right portion of the display.
14. Press the left RESULT switch until GEN FREQ appears in the left portion of the display.
15. Set the ANALYSIS MODE switch to the CONTINUOUS position.
16. Verify that the ANALYSIS RESULTS displays show the following:

GEN FREQ	RCV FREQ
64000.0	64000.0

2.8.2.2 Synchronous Transmit and Receive Self-Test

To verify the operation of the FIREBERD 6000's transmit and receive circuitry, do the following:

1. If the 10^{-3} indicator (located just below the DATA switch) is illuminated, press the ERROR INSERT switch to turn it off.
2. In the ANALYSIS RESULTS area, set the right CATEGORY switch to the ERROR position.
3. Press the right RESULT switch until BIT ERRS appears in the right portion of the display.
4. After pressing the RESTART switch, verify that:
   - The SYNC indicator is illuminated.
   - The bit error display shows no (0) errors.
   - The SYNC LOST indicator is off.

2.8.2.3 Error Counter and Error Insert Self-Test

To verify the operation of the FIREBERD 6000's error counter and error insert function, do the following:

1. If the 10^{-3} indicator (located just below the DATA switch) is illuminated, press the ERROR INSERT switch to turn it off.
2. In the ANALYSIS RESULTS area, set the right CATEGORY switch to the ERROR position.
3. Press the right RESULT switch until BIT ERRS appears in the right portion of the display.
4. Press the ERROR INSERT pushbutton switch once and verify that the BIT ERRS count has increased from 0 to 1.
5. Adjust the volume control (located to the right of the TIMING MODE switch) until the unit "beeps" when the ERROR INSERT switch is pressed.
6. Hold the ERROR INSERT switch until the 10^{-3} indicator illuminates and verify that the BIT ERRS count is increasing rapidly. A tone should be audible during every second that errors are inserted.
7. Set the MENU switch to the TEST INTERVAL position.

8. If not visible in the display, press the illuminated MORE key until the 10^6 selection appears.

9. Press the 10^6 softkey.

10. Press the right RESULT switch until the BER result appears in the display. Wait approximately 15 seconds, then verify that the BER result is 1.00 E-03.

2.8.2.4 Seconds and Blocks Self-Test

To self-test the FIREBERD 6000 for seconds and block measurements, do the following:

1. Set the MENU switch to the SYNTH FREQ position. Using the keypad, type the number 1 and press ENTER.

2. In the ANALYSIS RESULTS area, set the left CATEGORY switch to the TIME position.

3. Press the left RESULT switch until EF EAS appears in the left portion of the display.

4. If the 10^{-3} indicator (located just below the DATA switch) is illuminated, press the ERROR INSERT switch to turn it off.

5. Set the MENU switch to the AUXILIARY position. Using the MENU keypad, type the number 30 and press ENTER, then type the number 1000 and press ENTER.

6. Press the RESTART pushbutton switch, then verify that EA SEC count in the left display is increasing by one per second.

7. Set the right CATEGORY switch to the TIME position.

8. Press the right RESULT switch until EA SEC appears in the right portion of the display. Verify that the EA SEC count is identical to that of EF EAS.

9. Set the right CATEGORY switch to the ERROR position. Using the right RESULT switch, check the right portion of the display to verify that these results are being measured correctly:

BLK ERRS	Zero (0)
BLOCKS	Identical to EA SEC

2.8.2.5 Data Generator Self-Test

To verify the operation of the data generator, do the following:

1. Set the DATA switch to the MARK position.

2. Set the MENU switch to the SYNTH FREQ category. Using the MENU keypad, type the number .05 and press ENTER.

3. Verify that the MK indicator (located in the top right corner of the unit) is illuminated.

4. Press the ERROR INSERT pushbutton switch numerous times and verify that the SP indicator (located below the MK indicator) briefly illuminates.

5. Set the DATA pushbutton switch to the 1:1 position; verify that the MK and SP indicators are both flashing.

6. Using the MENU keypad, change the synthesizer frequency to 5 kHz by typing the number 5 and pressing ENTER.

7. Press the DATA switch to scroll through all pattern positions; verify that the SYNC indicator is illuminated for each position except FOX* and USER*.

2.8.2.6 Time and Date Self-Test

To verify that the FIREBERD 6000 is recording the correct time and date, do the following:

1. Press the left RESULT switch until TIME appears in the left portion of the display; verify that the display shows the correct time.

2. Press the right RESULT switch until DATE appears in the right portion of the display; verify that the display shows the correct date.

NOTE: If the time and data are not accurate, they can be reset using Auxiliary Function 60 (see Section 4).

*SYNC indicator will illuminate in FOX and USER positions when the Long User Pattern (i.e., 2048-character, user-programmable message) is installed.

SECTION 3
INSTRUMENT DESCRIPTION

3.1 SECTION SUMMARY

This section describes the FIREBERD 6000's front-panel switches and indicators (Figure 3-1). It also describes the connectors and test points on the rear panel.

3.2 THE FIREBERD 6000 FRONT PANEL

As shown in Figure 3-1, the FIREBERD 6000 front panel is composed of a variety of switches and indicators.

The FIREBERD 6000 features two types of switches:

- Electronic slide switch
- Single-function switch

An electronic slide switch features a column of labeled LED indicators above a single key. The illuminated LED indicator shows the current selection of the switch; pressing and releasing the key changes the current selection. An example of an electronic slide switch is the DATA switch (described on Page 3-13).

A single-function switch is a simple "press and release" key that controls one activity. Many single-function switches have LEDs that illuminate to show the current setting of the switch. An example of a single-function switch is the RE-START switch (Page 3-37); an example of a single-function switch with an LED is the SELF LOOP switch (Page 3-43).

The FIREBERD also features two types of indicators: discrete LED indicators with adjacent labels, and panel labels with backlighting. An example of a discrete LED with an adjacent label is the SYNC indicator (Page 3-45). An example of a panel label is the AUX FUNC IN USE indicator (Page 3-9).

3.3 FRONT-PANEL SWITCH AND INDICATOR REFERENCE

This section describes the FIREBERD 6000's front-panel switches and indicators in alphabetical order, as follows:

SWITCH/INDICATOR:	DESCRIBED ON PAGE:
ALM1 and ALM2	3-4
ANALYSIS MODE	3-4
ANALYSIS RESULTS	3-5
AUX FUNC IN USE	3-9
CLK INV	3-10
CODE	3-11
CTS	3-12
DATA	3-13
DATA INV	3-18
DISPLAY HOLD	3-19
DSR (DM) LED INDICATOR	3-20
DSR (DM) SWITCH	3-21
DTR LED INDICATOR	3-22
DTR SWITCH	3-23
EMULATE DCE	3-24
EMULATE DTE	3-25
ERROR INSERT	3-26
FRM SYNC	3-27
GEN CLK	3-28
(LL)	3-29
LOOP DOWN	3-30
LOOP UP	3-31
MENU	3-32
MK	3-33
NO CLK	3-34
POWER	3-35
PRINTER	3-36
RESTART	3-37
(RL)	3-38
RLSD (RR) LED INDICATOR	3-39
RLSD (RR) SWITCH	3-40
RTS LED INDICATOR	3-41
RTS SWITCH	3-42
SELF LOOP	3-43
SP	3-44
SYNC	3-45
SYNC LOST	3-46
TIMING MODE	3-47
(TM)	3-49
VOLUME	3-50

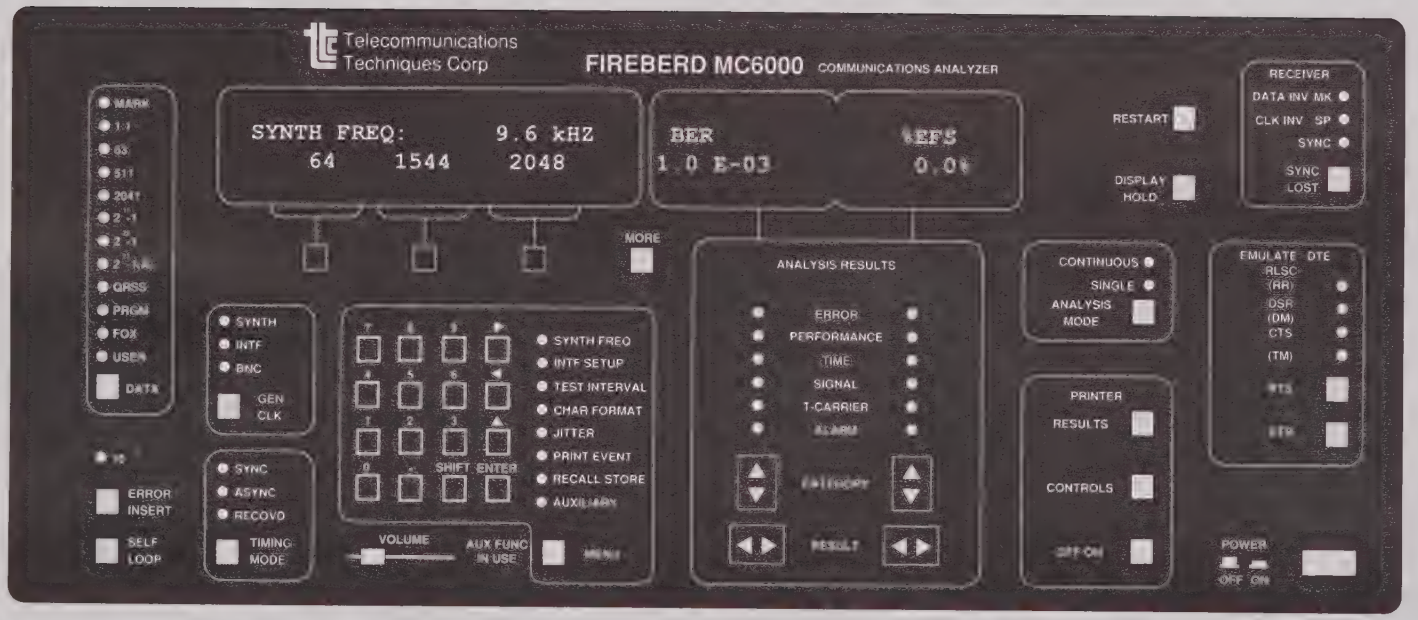
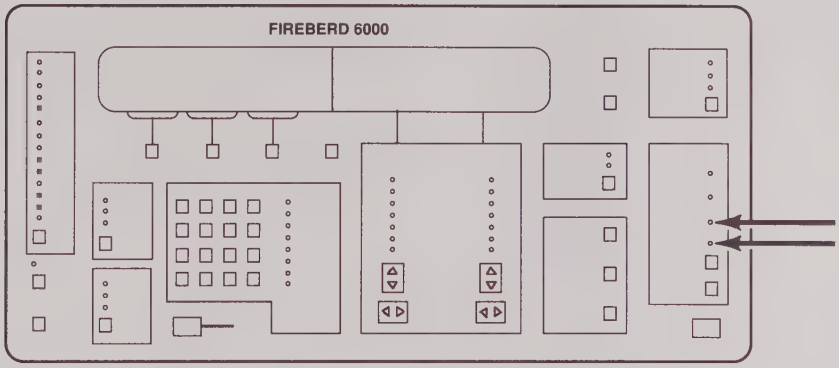


Figure 3-1
The FIREBERD 6000 Front Panel

ALM1 AND ALM2

Interface-Specific Alarm Conditions



Front-Panel Component-Type:

Discrete LED indicators with adjacent labels (see Section 3.2).

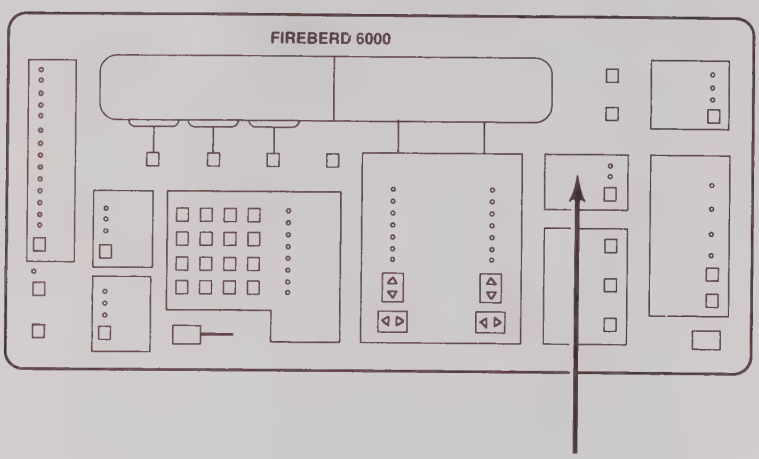
Purpose:

The ALM1 and ALM2 LED indicators signal the presence of an interface-specific alarm condition. When illuminated, check the manual associated with the currently selected interface for the specific cause of the alarm.

ANALYSIS MODE

ANALYSIS MODE

Run a Single Test or a Continuous Test



Front-Panel Component-Type:

Electronic slide switch (see Section 3.2).

Purpose:

The ANALYSIS MODE switch determines whether a test is run continuously or for a selected interval.

Select:	To:
CONTINUOUS	Run a test indefinitely and continuously accumulate test results.
SINGLE	Run a test and accumulate test results for a specific test interval only.

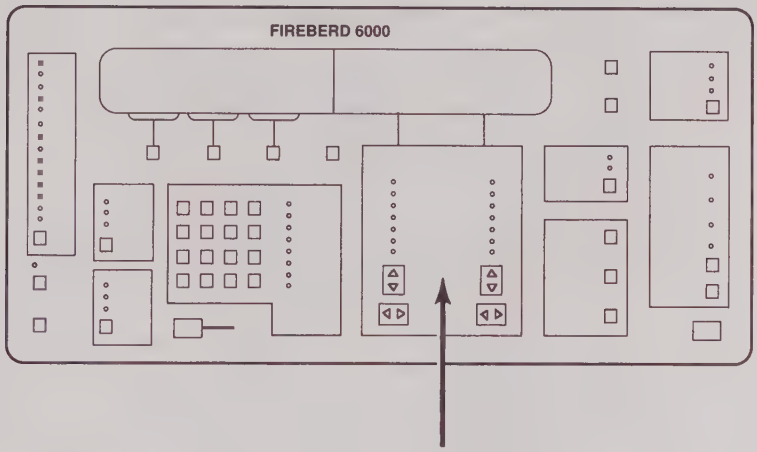
Notes:

1. In SINGLE mode, the actual length of the test is determined by the TEST INTERVAL function of the MENU switch. (See Section 4 for a complete description of this function.)

2. In SINGLE mode, transmission continues even though test time has expired. However, no analysis is performed.

ANALYSIS RESULTS

Collect Test Results



Front-Panel Component-Type:

CATEGORY: Electronic slide switch (see Section 3.2).
RESULT: Single-function switch (see Section 3.2).

Purpose:

The two sets of ANALYSIS RESULTS switches control the display of test results. The left and right CATEGORY switches are used to select an analysis category for display. The left and right RESULT switches are used to scroll and display a specific analysis result from each category.

Two CATEGORY and RESULT switches are available to permit any pair of test results shown below to be displayed simultaneously. *Since many of these results are interface- and mode-specific, not all of them will appear when running a given test.*

USE THE CATEGORY SWITCH TO SELECT:	USE THE RESULT SWITCH TO DISPLAY:
ERROR	BIT ERRS (Bit Errors) AVG BER (Average Bit Error Rate) BER (Bit Error Rate) BLOCKS (Blocks) BLK ERRS (Block Errors) AVG BLER (Average Block Error Rate) CHAR ERR (Asynchronous Character Errors) PAT SLIP (Pattern Slips)
PERFORMANCE	G.821 ERR SEC (Errored Seconds) G.821 EFS (Error-Free Seconds) G.821 %EFS (Percent Error-Free Seconds) DEG MIN (Degraded Minutes) %DEG MIN (Percent Degraded Minutes) SES (Severely Errored Seconds) %SES (Percent Severely Errored Seconds)

ANALYSIS RESULTS

Collect Test Results (Continued)

USE THE CATEGORY SWITCH TO SELECT:	USE THE RESULT SWITCH TO DISPLAY:
PERFORMANCE (continued)	G.821 VFS (Violation-Free Seconds) G.821 %VFS (Percent Violation-Free Seconds) UNA SEC (Unavailable Seconds) AVL SEC (Available Seconds) %AVL SEC (Percent Available Seconds) SVS (Severely Violated Seconds) %SVS (Percent Severely Violated Seconds) BER-SES (Bit Error Rate Minus Severely Errored Seconds) ERR-SES (Bit Errors Minus Severely Errored Seconds)
TIME	ERR EAS (Errored Error Analysis Seconds) E A SEC (Error Analysis Seconds) E F EAS (Error-Free Error Analysis Seconds) ELAP SEC (Elapsed Seconds) TIME (Time) DATE (Date) %ACT SEC (Percent Active Seconds) PATL SEC (Pattern Sync Loss Seconds) %PAT SEC (Percent Synchronized Seconds) SIGL SEC (Signal Loss Seconds)
SIGNAL	DELAY (Delay) MAX JTR (Maximum Jitter) 1SEC JTR (One-Second Jitter) JTR HITS (Jitter Hits) +WNDR (Positive Peak-to-Peak Wander) -WNDR (Negative Peak-to-Peak Wander) PP WNDR (Peak-to-Peak Wander) 15m WNDR (15-Minute Wander) 24h WNDR (24-Hour Wander) TIE WNDR (Tie Wander) RCV FREQ (Receiver Clock Frequency) GEN FREQ (Generator Clock Frequency) %MASK (Maximum Percent of Jitter Mask) S/A nnn (Spectrum Analyzer Frequency) RCV BYTE (Receive Byte) RCV CODE (Receive Code) PWR STAT (ISDN Power Feeding Status) R LVL-V (Receiver Signal Level in Volts) R LVL-dB (Receiver Signal Level in Decibels) TX INFO (Transmitter Information Sequence State) RX INFO (Receiver Information Sequence State) TEI (Terminal Equipment Identifier Assigned) +LVL V (Positive Level in Volts) +LVL dB (Positive Level in Decibels) -LVL V (Negative Level in Volts) -LVL dB (Negative Level in Decibels) PP LVL V (Peak-to-Peak Level in Volts) LVL dBm (Power Level of All-Ones Signal in dBm) DAT RATE (Data Rate) SMPX CUR (Simplex Current)

Collect Test Results (Continued)

USE THE CATEGORY SWITCH TO SELECT:	USE THE RESULT SWITCH TO DISPLAY:
T-CARRIER	BPVs (Bipolar Violations) BPV RATE (Bipolar Violation Rate) AVG BPVR (Average Bipolar Violation Rate) CODE ERR (Code Error Rate) CER (Code Error Rate) AVG CER (Average Code Error Rate) VF EAS (Violation-Free Error Analysis Seconds) %VF EAS (% Violation-Free Error Analysis Seconds) FRA ERR (Frame Errors) FE RATE (Frame Error Rate) AVG FER (Average Frame Error Rate) FRA LOSS (Frame Synchronization Loss) CRC ERR (CRC Errors) CRC E Rt (CRC Error Rate) AVG CRC (Average CRC Errors) FAS ERR (Frame Alignment Signal Error) FAS E Rate (Frame Alignment Signal Error Rate) AVG FAS (Average Frame Alignment Signal Error Rate) 1SEC CRC (One-Second CRC Errors) L2 F ERR (Layer 2 Frame Errors) FCS ERR (Frame Check Sequence Errors) L2 ABORT (Layer 2 Frame Abort) L2 FRMS (Number of Layer 2 Frames) REJ FRM (Rejection Frames) FRMR (Frame Rejection Frames) MAX ZERO (Maximum Consecutive Zeros) BIT SLIP (Bit Slips) RCV BOM (Received Bit-Oriented Message) RX ABCD (DS0 ABCD Signal)
ALARM	PAT LOSS (Pattern Synchronization Loss Count) DAT LOSS (Receiver Data Loss Count) CLK LOSS (Receiver Clock Loss Count) C-D CHA (Clock-Data Phase Change) PWR LOSS (Power Loss) SIG LOSS (Receiver Signal Loss) YEL SEC (Yellow Alarm Seconds) XS0 SEC (Excess Zero Seconds) AIS SEC (Alarm Indication Signal Seconds) 1S DEN S (Ones Density Violation Seconds) V FR SEC (Violated Frame Seconds) REM SEC (Remote Alarm Seconds)

ANALYSIS RESULTS

Collect Test Results (Continued)

Notes:

1. Certain results associated with the T-CARRIER analysis category do not necessarily apply to T1, T1C, or T2 testing. Many results are specific to a single interface, as follows:

Interface:	Result:
ISDN S/T Interface (Model 41075)	Layer 2 Frame Errors Frame Check Sequence Errors Layer 2 Frames Layer 2 Frame Aborts Rejection Frames Frame Rejection Frames
T1/FT1 Interface (Model 41440)	DS0 ABCD Signal Maximum Consecutive Zeros Bit Slips Received Bit-Oriented Message
G.704 2048 kb/s Framing Interface (Model 30609)	Code Errors Code Error Rate Frame Alignment Signal (FAS) Errors FAS Error Rate Average FAS Error Rate

   See the *FIREBERD 6000 User's Guide* for a description of the test results that are specific to a variety of interfaces and test scenarios.

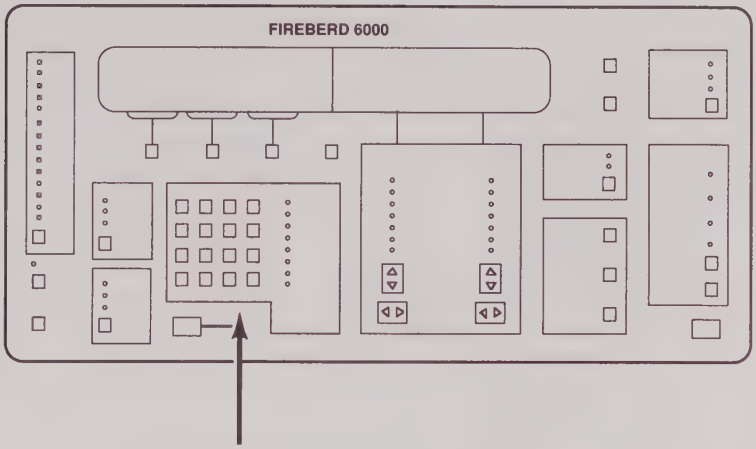
2. The left and right CATEGORY and RESULT switches are identical (i.e., both sides work the same way and offer the same analysis categories and results).

3. Section 5 of this manual features a full description of all test results.

AUX FUNC IN USE

AUX FUNC IN USE

Status-Select Auxiliary Function In Use



Front-Panel Component-Type:

Panel label with backlighting (see Section 3.2).

Purpose:

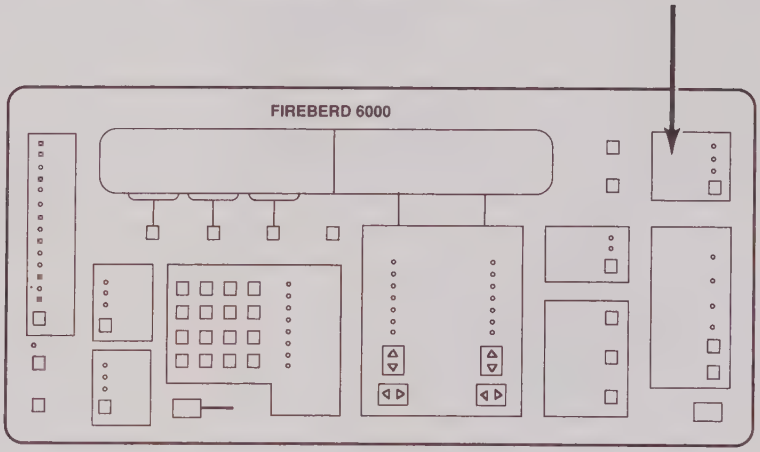
The AUX FUNC IN USE label indicates that at least one of the FIREBERD 6000's status-select auxiliary functions is not in a default state.

For example, the default setting for generator clock polarity (Auxiliary Function No. 1) is NORMAL; when generator clock polarity is set to INVERT, the AUX FUNC IN USE label is illuminated.

Note that only auxiliary functions 1-10 are classified as status-select. Section 4 fully describes all the auxiliary functions that are available with the FIREBERD 6000.

CLK INV **CLK INV**

Inverted Clock Indicator



Front-Panel Component-Type:

Panel label with backlighting (see Section 3.2).

Purpose:

When conducting an out-of-service test with an RS-232, V.35, or RS-449 data interface, the CLK INV indicator illuminates when the FIREBERD 6000 detects an improper phase relationship between the incoming clock and data.

For example, if the sampling edge of the clock (as defined by the applicable interface standard) is, on the average, closer to the data transitions than to the mid-bit position of the data, an inverted clock condition is declared and the CLK INV indicator is illuminated.

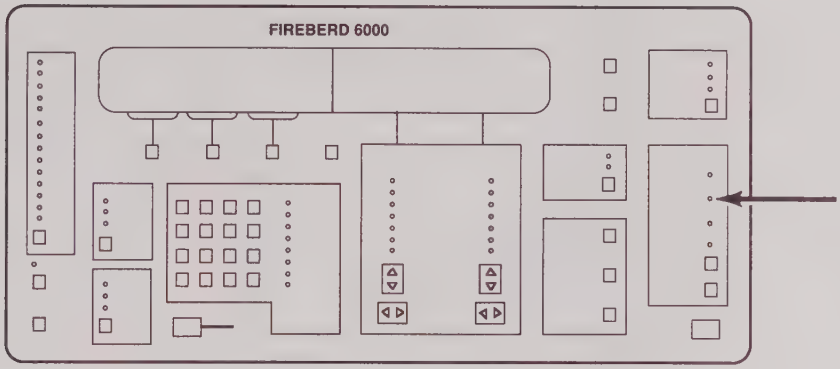
Notes:

1. Inverted clock detection takes place only when the FIREBERD 6000 is in synchronous timing mode, described on Page 3-47.

CODE

CODE

Code Indicator



Front-Panel Component-Type:

Discrete LED indicator with adjacent label (see Section 3.2).

Purpose:

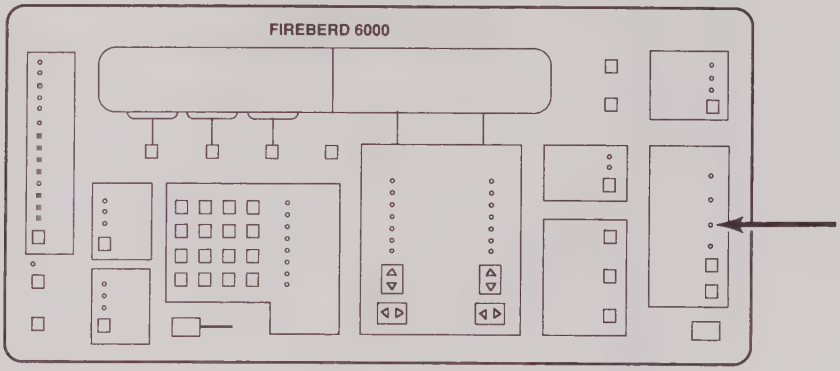
When the FIREBERD 6000 is used to test T1 or DDS, the CODE indicator illuminates when a specific type of code is received, as follows:

Model:	Interface:	CODE LED Illuminates When:
40540	DS1/T1/D4/ESF/SLC-96 Interface	B8ZS code is received.
40460	DS1/T1/D4/ESF Interface	B8ZS code is received.
41131/ 41231	DDS Local Loop Interface	The idle code is detected on the channel being analyzed.
30678	DDS DS0A/B Interface	The interface initiates an alternating loopback and is receiving the correct loop code along with the test data.

CTS

CTS

Clear To Send (CTS) Indicator



Front-Panel Component-Type:

Discrete LED indicator with adjacent label (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DTE, the CTS indicator shows the state of the connecting DCE's Clear To Send (CTS) signaling lead.

Notes:

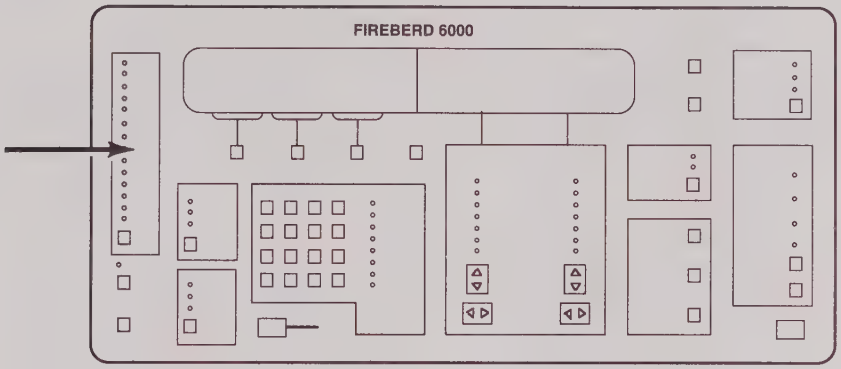
1. The enabling of signaling leads is an activity normally associated with *out-of-band flow control*. In out-of-band flow control, data transmission takes place only when certain signaling leads are placed in the ON state (i.e., enabled). In either DTE or DCE emulation, data transmission may be conditioned upon the enabling of any or all of these leads:

Signaling Lead:	Described on Page:
CTS	3-12
DSR (DM)	3-20/3-21
DTR (TR)	3-22/3-23
RLSD (RR)	3-39/3-40
RTS	3--41/3-42

2. Auxiliary Function 08 (OUT-BAND FLOW) allows the user to specify which signaling leads must be in the ON state for data transmission to take place. This auxiliary function is fully described in Section 4.

DATA

Select A Data Pattern Or Message



Front-Panel Component-Type:

Electronic slide switch (see Section 3.2).

Purpose:

The DATA switch selects a pattern or message to be transmitted when conducting an out-of-service test. In out-of-service testing, live traffic must be removed from the digital circuit before testing can begin. In its place, the FIREBERD 6000 transmits the currently selected data pattern either to another test instrument or to itself via loopback. The received data is then analyzed for errors.

Pattern:	Description:	Provides:
MARK	All ones, fixed, "keep-alive" pattern. Equivalent to Red Alarm Signal..	Maximum power level for T1 signal. Stresses T1 repeater's minimum power requirements. Also useful for signal tracing or as an ideal pattern.
1:1	Fixed pattern of single alternating Marks and Spaces.	Minimum stress on clock recovery circuits.
63	2^6-1 pseudorandom pattern with a maximum of 5 sequential zeroes and 6 sequential ones.	Lowest stress of any pseudorandom pattern. Recommended for synchronous and asynchronous testing.
511	2^9-1 pseudorandom pattern with a maximum of 8 sequential zeroes and 9 sequential ones.	Compatibility with DDS equipment. Recommended when testing below the rate of 9.6 kb/s.
2047	2^{11}-1 pseudorandom pattern with a maximum of 10 sequential zeroes and 11 sequential ones.	Compatibility with DDS equipment. Suited for testing at data rates between 9.6 and 56 kb/s.

DATA **DATA**

Select a Data Pattern or Message (Continued)

Pattern:	Description:	Provides:
2^{15}-1	Pseudorandom pattern with a maximum of 14 sequential zeroes and 15 sequential ones.	Compatibility of O.151 specification for 64, 1544, 2048, 3152 and 6312 kb/s data rates. Provides maximum number of sequential zeroes allowable in framed, non-B8ZS testing. Recommended for testing at data rates above 19.2 kb/s. Standard for G.703 testing.
2^{20}-1	Pseudorandom pattern with a maximum of 19 sequential zeroes and 20 sequential ones.	Higher stress than the 2^{15}-1 pattern. Recommended for T1 applications where excess zero transmission is required. Cannot be used in asynchronous timing mode.
2^{23}-1	Pseudorandom pattern with a maximum of 22 sequential zeroes and 23 sequential ones.	Highest stress of all pseudorandom patterns. Cannot be used in asynchronous timing mode.
QRSS	2^{20}-1 pattern modified to transmit a maximum of 14 consecutive zeroes.	Simulation of live data. QRSS is the standard data pattern for T1 testing. Cannot be used in asynchronous timing mode.
PRGM	A user-programmable bit pattern, configured using Auxiliary Function 33.	The ability to generate a 3-to-24 bit user programmable pattern.
FOX	A message that includes the numbers 0-9 and all upper case letters (THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789). When both the Long User Pattern and synchronous timing are used, a 7-bit QUICK BROWN FOX ASCII message is transmitted. In asynchronous mode, the FOX message is transmitted according to the number of data bits specified in the character format. 5 bits: Baudot 6 bits: BCDIC 7 bits: ASCII 8 bits: EBCDIC	The standard asynchronous pattern for teletype communications. Also useful as the payload of synchronous protocols.
USER	Selects the pattern currently specified in Auxiliary Function 41.	The ability to use one of three Long User Patterns programmed in Auxiliary Function 41, or one of the additional "canned" patterns also offered in Auxiliary Function 41.

Notes:

1. In addition to the patterns which can be selected via the DATA switch, still more are available using Auxiliary Function 41 (see Section 4), as follows:

Select a Data Pattern or Message (Continued)

Notes (continued):

Pattern:	Description:	Provides:
1:7	Fixed pattern of 1 Mark and 7 Spaces.	Maximum stress of the 12.5% ones density requirements for T1 circuits. Cannot be used in asynchronous timing mode.
3-IN-24	Fixed 24-bit pattern of 1 Mark and 3 Spaces (3 times) followed by 15 consecutive Spaces. The pattern appears as 1000 1000 1000 0000 0000 0000.	Maximum stress of the excess zero requirement for T1 circuits. Cannot be used in asynchronous timing mode.
DDS-1	Fixed pattern of 100 octets with all ones (11111111), followed by 100 octets with all zeros (00000000).	Stress of any DDS circuit's minimum and maximum power requirements for signal recovery. A FIREBERD equipped with Long User Pattern capability is required. Cannot be used in asynchronous timing mode.
DDS-2	Fixed pattern of 100 octets of 01111110, followed by 100 octets of all zeros.	Simulation of an HDLC packet frame. A FIREBERD equipped with Long User Pattern capability is required. Cannot be used in asynchronous timing mode.
DDS-3	Fixed pattern 00110010.	Minimum stress test of a DDS circuit. Cannot be used in asynchronous timing mode.
DDS-4	Fixed pattern 01000000.	Moderate stress on DDS clock recovery circuits. Cannot be used in asynchronous timing mode.
DDS-5	7-octet fixed pattern of 1111 1110 followed by 1 octet of 1111 1111.	Simulation of a DDS signal transition from IDLE mode to DATA mode. Detects marginal equipment in multipoint applications. A FIREBERD equipped with Long User Pattern capability is required. Cannot be used in asynchronous timing mode.
DDS-6	A compilation of DDS patterns 1-4.	A quick test for individuals who wish to test a circuit with DDS patterns 1-4.
T1-1	Fixed 72-octet hex pattern: 80 80 80 80 01 00 01 01 01 03 80 01 80 01 01 80 01 22 00 20 22 00 20 AA AA AA AA AA 55 55 55 55 AA AA AA AA 55 AA AA 55 55 55 80 80 FF FF FF FF FF FF FF FE FF FF 24 49 92 88 88 88 10 42 08 21 84 20 08 82 40 20 10 80.	Stress testing of the repeater pre-amplifier and automatic line build-out (ALBO) circuitry. Detects marginal equipment using rapid transitions from a low ones density to a high ones density. A FIREBERD equipped with Long User Pattern capability is required. Not available in asynchronous timing mode.

DATA

Select a Data Pattern or Message (Continued)

Notes (continued):

Pattern:	Description:	Provides:
T1-2	Fixed 96-octet hex pattern: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF AA AA AA AA 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 AA AA AA AA 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01.	Empirical stress testing of T1 circuits and equipment. A FIREBERD equipped with Long User Pattern capability is required. Not available in asynchronous timing mode.
T1-3	Fixed 54-octet hex pattern: 01 01 01 01 01 01 00 01 01 01 01 01 01 03 01 01 01 01 07 01 01 01 55 55 55 55 AA AA AA AA 01 01 01 01 01 01 FF FF FF FF FF FF 80 01 80 01 80 01 80 01 80 01 80.	Empirical stress testing of T1 circuits and equipment. A FIREBERD equipped with Long User Pattern capability is required. Not available in asynchronous timing mode.
T1-4	Fixed 120-octet hex pattern: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF AA AA AA AA 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 AA AA AA AA 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10 10.	Empirical stress testing of T1 circuits and equipment. A FIREBERD equipped with Long User Pattern capability is required. Not available in asynchronous timing mode.
T1-5	Fixed 53-octet hex pattern: 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 80 01 AF AA AF 01 01 01 01 FF FF FF FF 01 01 01 01 FF FF FF FF FF FF CB.	Empirical stress testing of T1 circuits and equipment. A FIREBERD equipped with Long User Pattern capability is required. Not available in asynchronous timing mode.

DATA

Select a Data Pattern or Message (Continued)

Notes (continued):

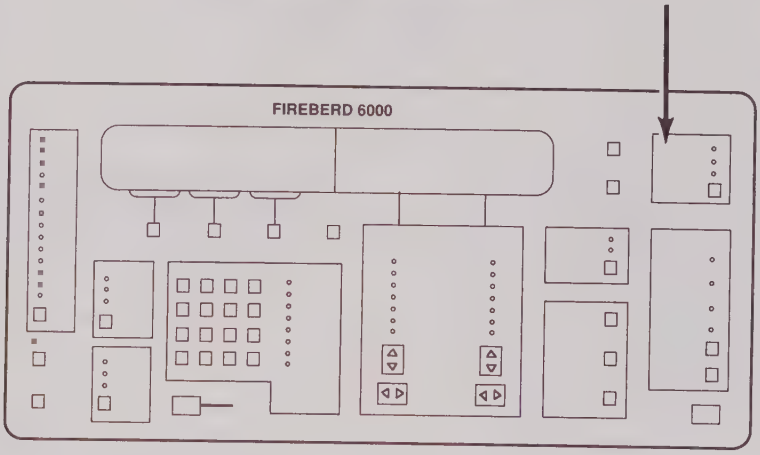
Pattern:	Description:	Provides:
T1-6	Fixed 55-octet hex pattern: 01 01 01 01 01 01 00 01 01 01 01 01 01 03 01 01 01 01 07 01 01 01 01 55 55 55 55 AA AA AA AA 01 01 01 01 01 01 FF FF FF FF FF FF 80 01 80 01 80 01 80 01 80 01 80 01.	Empirical stress testing of T1 circuits and equipment. A FIREBERD equipped with Long User Pattern capability is required. Not available in asynchronous timing mode.
T1-mW	Digitized 1004 Hz tone.	Standard tone used in Voice Frequency (VF) testing. A FIREBERD equipped with Long User Pattern capability is required.
USER1	A user-created message of up to 2048 hexidecimal characters.When a USER1 message is not programmed, the default pattern is T1-6.	A lengthy, user-specific test pattern. A FIREBERD equipped with Long User Pattern capability is required when in synchronous or recovered timing mode.
USER2	Same as USER1, with the exception of the default pattern: a 7-bit ASCII QUICK BROWN FOX message.	A lengthy, user-specific test pattern. A FIREBERD equipped with Long User Pattern capability is required in synchronous or recovered timing mode.
USER3	Same as USER2, with the exception of the default pattern: a 8-bit ASCII QUICK BROWN FOX message.	A lengthy, user-specific test pattern. A FIREBERD equipped with Long User Pattern capability is required in synchronous or recovered timing mode.

2. Data patterns are also described in detail in Section 5.2.2.

DATA INV

DATA INV

Inverted Data Indicator



Front-Panel Component-Type:

Panel label with backlighting (see Section 3.2).

Purpose:

When conducting an out-of-service test, the DATA INV indicator illuminates when the FIREBERD 6000 recognizes a data pattern that is the logical opposite of the one it originally expected to receive.

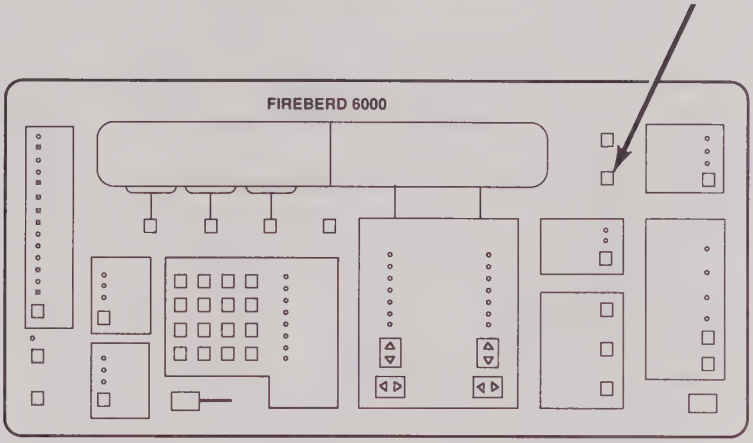
Notes:

1. The FIREBERD 6000 checks for data inversion if pattern synchronization has not been achieved after receipt of the first 128 bits in SYNC mode, or after 5 seconds have elapsed in ASYNC mode. When data inversion is detected, the FIREBERD 6000 uses its auto polarity circuits to reinvert the data, and enable both pattern synchronization and error analysis.

2. The Long User Pattern (i.e., user-created message of up to 2048 characters in length, programmed in USER1, USER2, or USER3) cannot synchronize to inverted data. See Auxiliary Function 41 (described in Section 4) for information on the long user pattern).

DISPLAY HOLD

Freeze Analysis Results



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

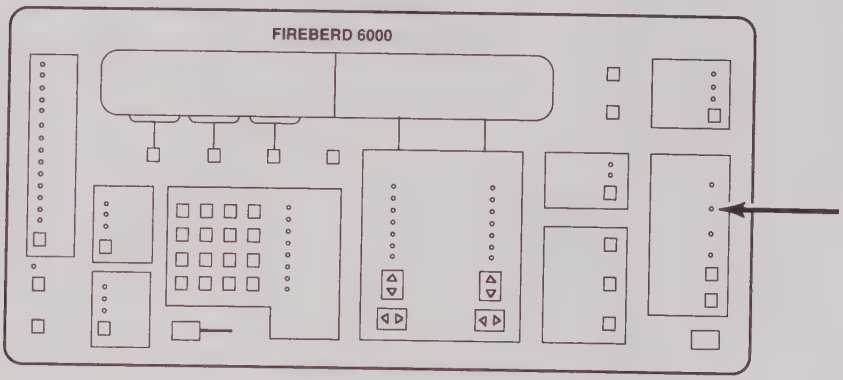
Purpose:

The DISPLAY HOLD switch freezes all analysis results so that the values of these results can be examined. When enabled, a red LED within the switch is illuminated to indicate that the results in the display are *not* the most current. Pressing the DISPLAY HOLD switch while it is illuminated enables the test results to be updated, and returns the displays to normal operation.

DSR (DM) LED INDICATOR

DSR (DM) LED INDICATOR

Data Set Ready (DSR) Indicator



Front-Panel Component-Type:

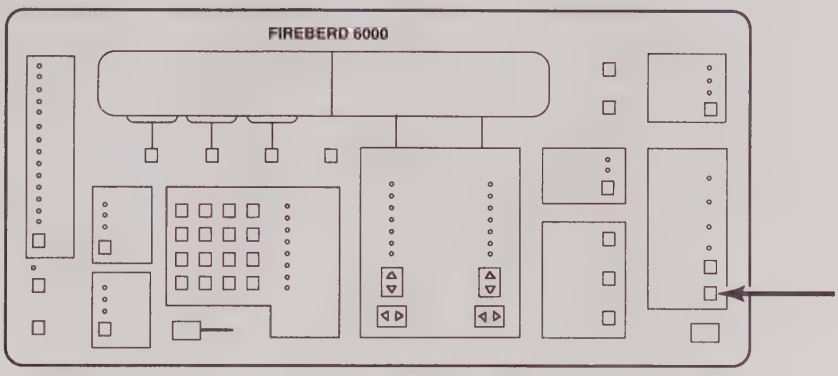
Discrete LED indicator with adjacent label (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DTE, the DSR (DM) indicator illuminates when the connecting DCE has enabled the Data Set Ready (DSR) signaling lead. When the DSR (DM) indicator is not illuminated, the DCE's DSR signaling lead is disabled.

DSR (DM) SWITCH

Data Set Ready (DSR) Line Control



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DCE, the DSR (DM) switch controls the state of the DSR signaling lead. When the switch is illuminated, the DSR signaling lead is enabled; otherwise, the DSR signaling lead is disabled.

Notes:

1. The enabling of signaling leads is an activity normally associated with *out-of-band flow control*. In out-of-band flow control, data transmission takes place only when certain signaling leads are placed in the ON state (i.e., enabled). In either DTE or DCE emulation, data transmission may be conditioned upon the enabling of any or all of these leads:

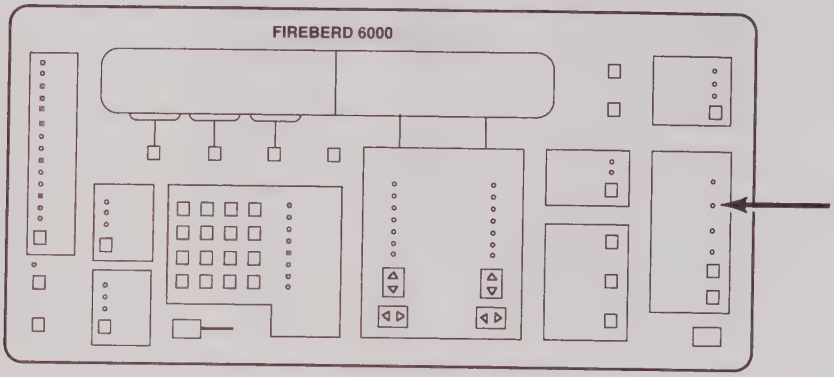
Signaling Lead:	Described on Page:
CTS	3-12
DSR (DM)	3-20/21
DTR (TR)	3-22/3-23
RLSD (RR)	3-39/3-40
RTS	341/42

2. Auxiliary Function 08 (OUT-BAND FLOW) allows the user to specify which signaling leads must be in the ON state for data transmission to take place. This auxiliary function is fully described in Section 4.

DTR LED INDICATOR

DTR LED INDICATOR

Data Terminal Ready (DTR) Indicator



Front-Panel Component-Type:

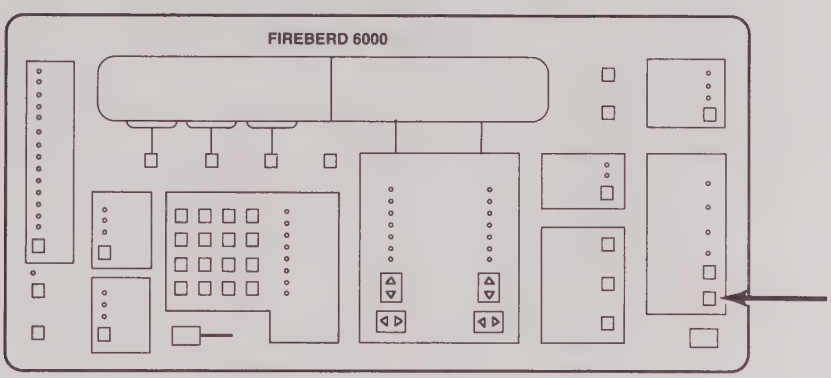
Discrete LED indicator with adjacent label (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DCE, the DTR indicator illuminates when the connecting DTE has enabled the Data Terminal Ready (DTR) signaling lead. When the DTR indicator is not illuminated, the DTE's DTR signaling lead is disabled.

DTR SWITCH **DTR SWITCH**

Data Terminal Ready (DTR) Line Control



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DTE, the DTR switch controls the state of the DTR signaling lead. When the switch is illuminated, the DTR signaling lead is enabled; otherwise, the DTR signaling lead is disabled.

Notes:

1. Enabling signaling leads is an activity normally associated with *out-of-band flow control*. In out-of-band flow control, data transmission takes place only when certain signaling leads are placed in the ON state (i.e., enabled). In either DTE or DCE emulation, data transmission may be conditioned upon the enabling of any or all of these leads:

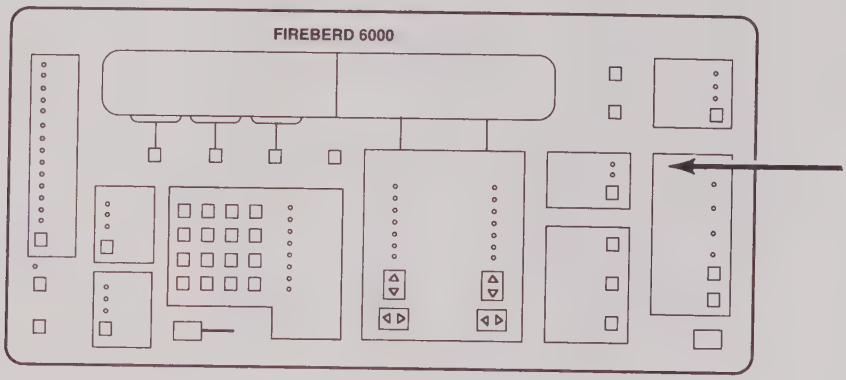
Signaling Lead:	Described on Page:
CTS	3-12
DSR (DM)	3-20/3-21
DTR (TR)	3-22/3-23
RLSD (RR)	3-39/3-40
RTS	3-41/3-42

2. Auxiliary Function 08 (OUT-BAND FLOW) allows the user to specify which signaling leads must be in the ON state for data transmission to take place. This auxiliary function is fully described in Section 4.

EMULATE DCE

EMULATE DCE

FIREBERD 6000 DCE Emulation Indicator



Front-Panel Component-Type:

Panel label with backlighting (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is used, this indicator shows that the FIREBERD 6000 is emulating Data Communications Equipment (DCE). Accordingly, the instrument backlights the DCE signaling leads and switches as follows:

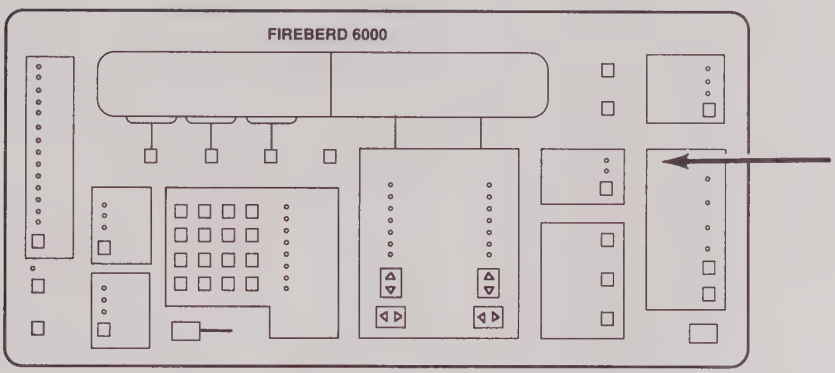
Label:	LED/Switch:	Described On Page:
RTS	LED	3-41
DTR	LED	3-22
(LL)	LED	3-29
(RL)	LED	3-38
RLSD (RR)	SWITCH	3-40
DSR (DM)	SWITCH	3-21

Notes:

1. All DCE emulation labels use RS-232 notation; RS-449 notation appears in parentheses.

EMULATE DTE

FIREBERD 6000 DTE Emulation Indicator



Front-Panel Component-Type:

Panel label with backlighting (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is used, this indicator shows that the FIREBERD 6000 is emulating Data Terminal Equipment (DTE). Accordingly, the instrument backlights the DTE signaling leads and switches as follows:

Label:	LED/Switch:	Described On Page:
RLSD (RR)	LED	3-39
DSR (DM)	LED	3-20
CTS	LED	3-12
(TM)	LED	3-49
RTS	SWITCH	3-42
DTR	SWITCH	3-23

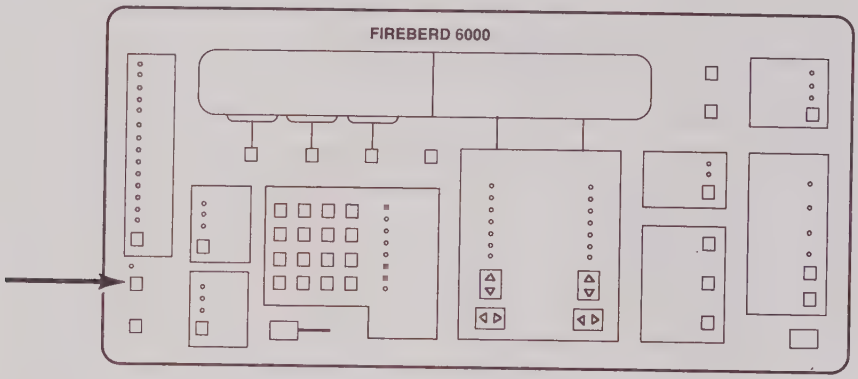
Notes:

1. All DTE emulation labels use RS-232 notation; RS-449 notation appears in parentheses.

ERROR INSERT

ERROR INSERT

Insert Single or Multiple Errors Into the Data Stream



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

The ERROR INSERT switch inserts a single error or a continuous stream of bit errors into the data stream.

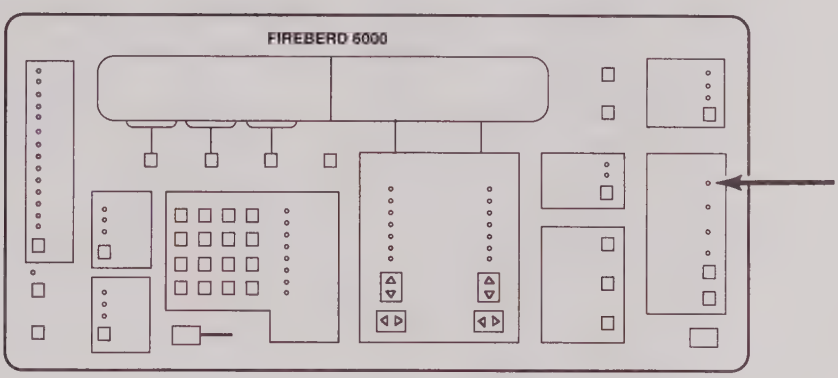
To insert a single error into the data stream, press and immediately release the switch. To insert errors at a continuous rate of 1 in 1000 bits, hold the switch for more than one second; during continuous error insertion, the 10^{-3} indicator is illuminated. To turn error insertion off, press and immediately release the switch while the 10^{-3} indicator is illuminated.

Notes:

1. The ERROR INSERT switch is disabled when monitoring live data.

FRM SYNC **FRM SYNC**

Frame Synchronization Indicator



Front-Panel Component-Type:

Discrete LED with adjacent label (see Section 3.2).

Purpose:

When using a T1 interface, the FRM SYNC indicator illuminates when synchronization to a valid T1 frame format (i.e., D4, ESF, or SLC-96) is achieved.

When using a DDS interface that can receive a DS0B signal or a DS0A signal at 19.2 kb/s, the FRM SYNC indicator illuminates when synchronization to the appropriate DS0 framing pattern is achieved.

When using the ISDN S/T interface or a G.703/G.704 interface, the FRM SYNC indicator illuminates when frame synchronization is achieved.

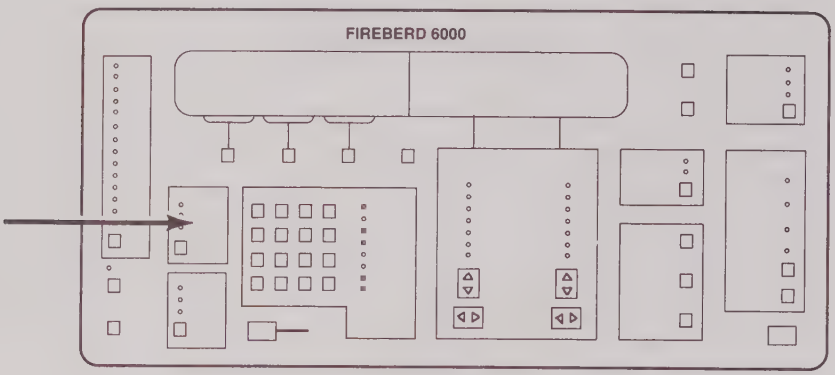
Notes:

1. The FRM SYNC indicator does not illuminate when testing unframed T1 or DDS applications.

GEN CLK

GEN CLK

Select a Signal Timing Source



Front-Panel Component-Type:

Electronic slide switch (see Section 3.2).

Purpose:

The GEN CLK switch selects the source of signal (transmit) timing when conducting an out-of-service test.

Select:	To:
SYNTH	Choose the FIREBERD 6000's built-in frequency synthesizer as the source of signal timing. The synthesizer generates any frequency within the range of 50 Hz to 15 MHz.
INTF	Choose the clock originating from the network or the clock in the interface module as a source of signal timing.
BNC	Choose an external timing source. When selected, the external timing source must be connected to the GEN CLK IN BNC connector on the FIREBERD 6000's rear panel.

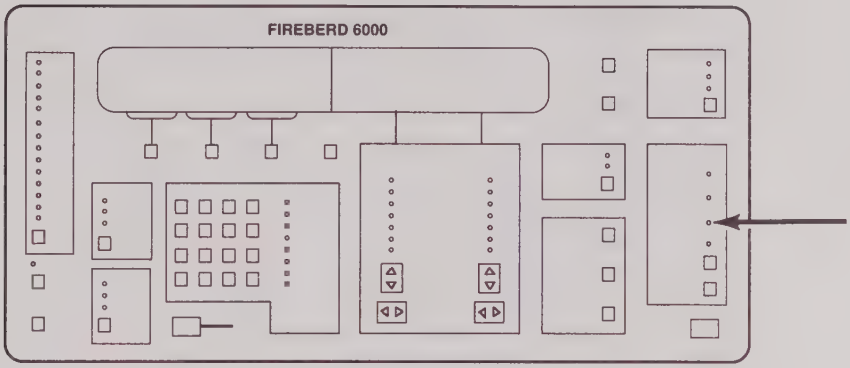
Notes:

1. The red LED within the GEN CLK switch illuminates when a clock signal cannot be detected at the selected source of signal timing.

2. When an interface can only operate with one timing source, the GEN CLK switch "freezes" on that selection (i.e., the user cannot change it). When an interface can only operate with two timing sources, the GEN CLK switch "locks out" the invalid choice.

(LL) (LL)

Local Loopback (LL) Indicator



Front-Panel Component-Type:

Discrete LED indicator with adjacent label (see Section 3.2).

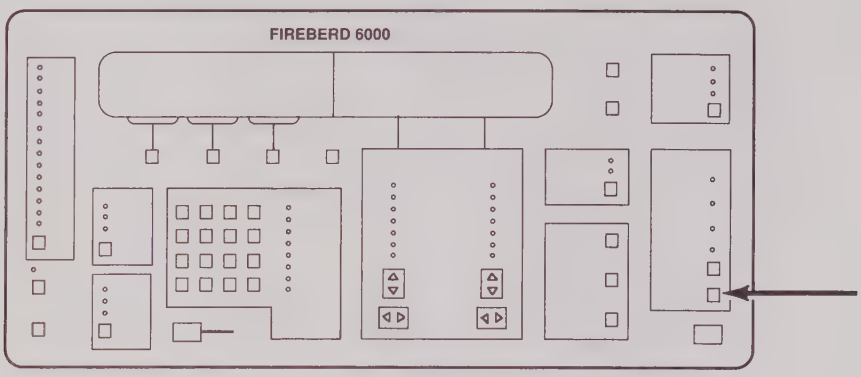
Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DCE, the (LL) indicator shows the state of the Local Loopback (LL) line. When the indicator is illuminated, the LL line is enabled; otherwise, the LL line is disabled.

LOOP DOWN

LOOP DOWN

Transmit Loop-Down Code



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

When an appropriate T-Carrier interface is used, the LOOP DOWN switch controls the transmission of loop-down code. When the switch is illuminated, loop-down code is being transmitted.

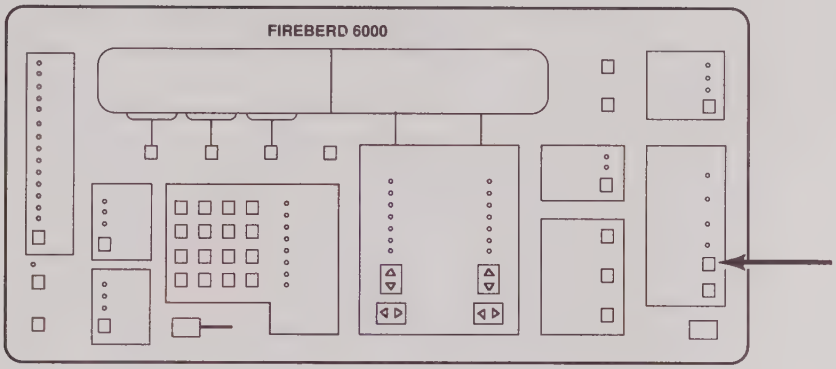
Notes:

1. When loop-down code is transmitted, the LOOP DOWN switch is illuminated and the message **Transmitting Loop Code** flashes repeatedly in the Analysis Results display. When the loop-down activity is complete, switch illumination is turned off and the flashing message is cancelled.

2. The LOOP DOWN switch should always be used at the conclusion of any loopback test to remove the effect of loop-up code (transmitted via the LOOP UP switch) on the circuit under test.

LOOP UP

Transmit Loop-Up Code



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

When a T-Carrier interface is used, the LOOP UP switch controls the transmission of loop-up code. When the switch is illuminated, loop-up code is being transmitted.

Notes:

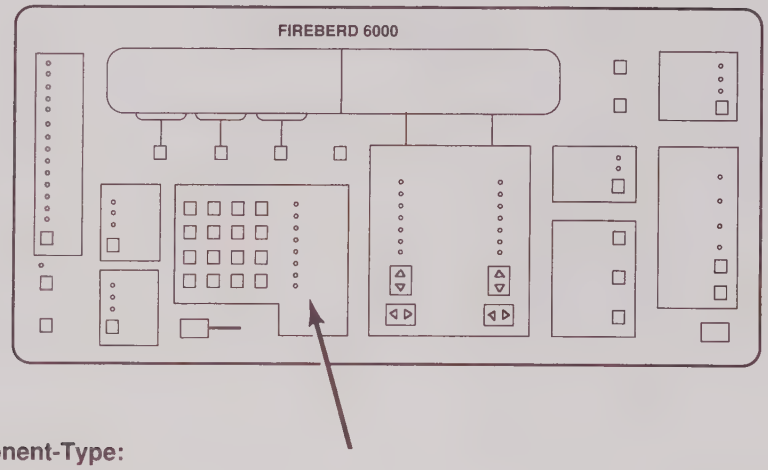
1. When loop-up code is transmitted, the LOOP UP switch is illuminated and the message **Transmitting Loop Code.** flashes repeatedly in the Analysis Results display. When the loop-up activity is complete, switch illumination is turned off and the flashing message is cancelled.

2. The LOOP DOWN switch must always be used at the conclusion of any loopback test to remove the effect of loop-up code on the circuit under test.

MENU

MENU

Select a Set-Up Menu For Display



Front-Panel Component-Type:

Electronic slide switch (see Section 3.2).

Purpose:

A key component of the FIREBERD 6000's test set-up facility, the MENU switch is used to select any of the instrument's eight menus for display, as follows:

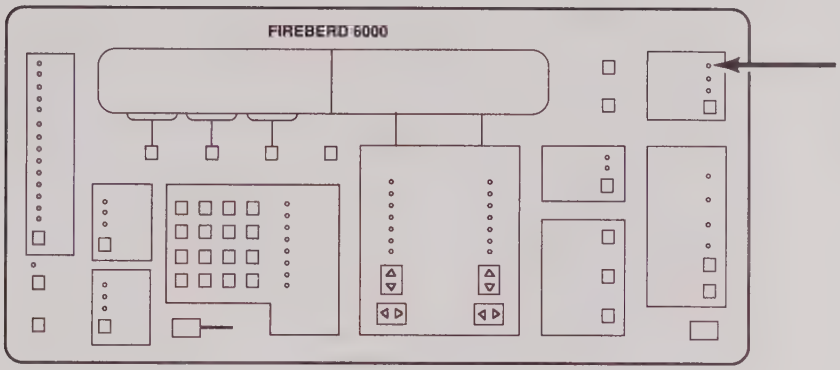
Select:	To:
SYNTH FREQ	Choose a synthesizer frequency.
INTF SETUP	Choose the built-in RS-232 interface or the modular interface installed in the rear panel of the FIREBERD 6000.
TEST INTERVAL	Choose a test interval.
CHAR FORMAT	Set the asynchronous character format.
PRINT EVENT	Set print event criteria.
RECALL/STORE	Store and recall up to 10 commonly used configurations.
AUXILIARY	Set up any of 29 additional configurable functions.

Section 4 fully describes the MENU switch and each of its individual components.

MK

MK

Mark Indicator



Front-Panel Component-Type:

Panel label with backlighting (see Section 3.2).

Purpose:

The MK indicator illuminates when a Mark (i.e., one) is detected in the received data.

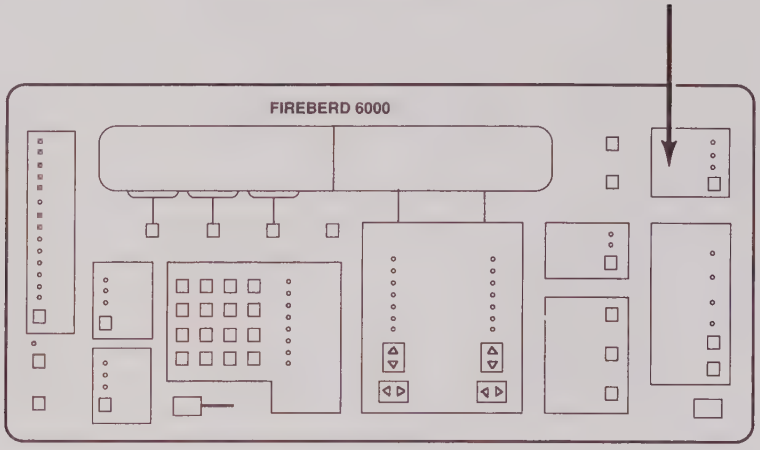
Notes:

1. Although not always apparent to the naked eye, the MK and SP indicators illuminate at different times (i.e., the SP indicator is off when a Mark is detected and vice versa).

NO CLK

NO CLK

No Receiver Clock Indicator



Front-Panel Component-Type:

Panel label with backlighting (see Section 3.2).

Purpose:

The NO CLK indicator illuminates when the selected timing mode requires a clock and there has been no receiver clock activity for 50 milliseconds.

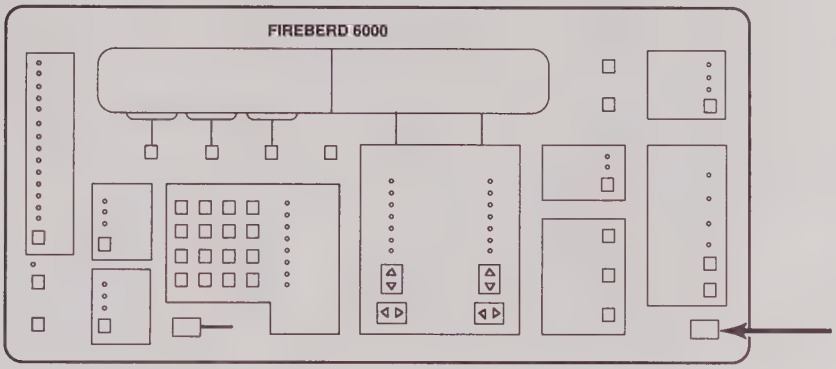
Notes:

1. A clock loss also forces frame and pattern synchronization loss.

POWER

POWER

Turn the FIREBERD 6000 On or Off



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

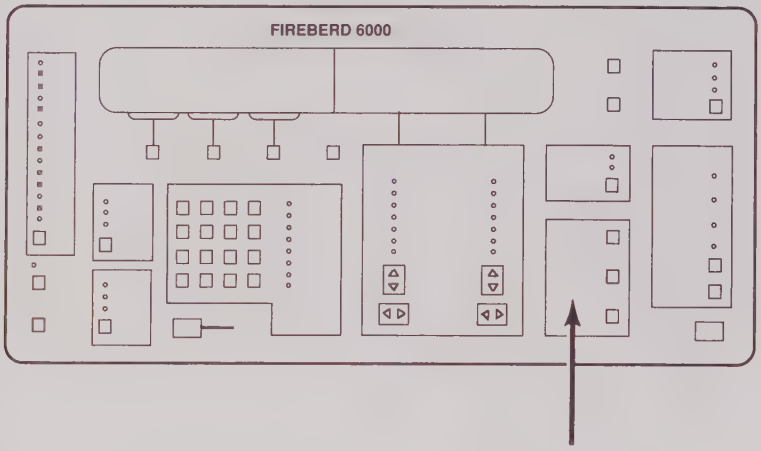
Purpose:

The POWER switch turns the FIREBERD 6000 on or off. The OFF and ON positions are displayed to the left of the switch.

PRINTER

PRINTER

Printer Control Block



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

PRINTER is a block of three switches that controls any printer attached to the FIREBERD 6000.

Select:	To:
ON/OFF	Enable printouts based on a specific event (e.g., a time interval or a bit error). An event is selected using the PRINT EVENT section of the MENU switch. See Section 4 for a complete description of all print event choices.
RESULTS	Obtain a copy of the most recent test results.
CONTROLS	Obtain a printout of the current test configuration.

Notes:

1. When the DISPLAY HOLD switch is enabled, the FIREBERD 6000 prints the most recent results accumulated rather than the values that are frozen in the display (i.e., the RESULTS PRINT switch is not affected by DISPLAY HOLD).

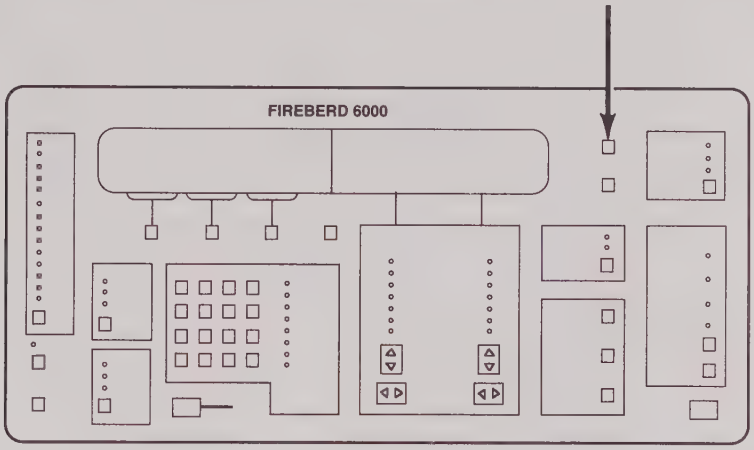
2. The print buffer is always cleared when the ON/OFF switch is placed OFF from the ON position.

3. Results and controls printouts may be obtained when the ON/OFF switch is in the OFF position; however, when the switch is placed OFF from the ON position, any printouts in progress are cancelled.

4. The ON/OFF switch is illuminated when in the ON position.

RESTART

Restart Test



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

The RESTART switch clears all accumulated analysis results; all tests and measurements are restarted.

Notes:

1. Pressing the RESTART switch also initiates data transmission in the Single Transmit mode, selected through Auxiliary Function 04. See Section 4 for a complete description of this auxiliary function.

2. Some of the more common events that cause a test restart are:

   a. Changing the data pattern.

   b. Changing the source of transmit timing.

   c. Changing the synthesizer frequency.

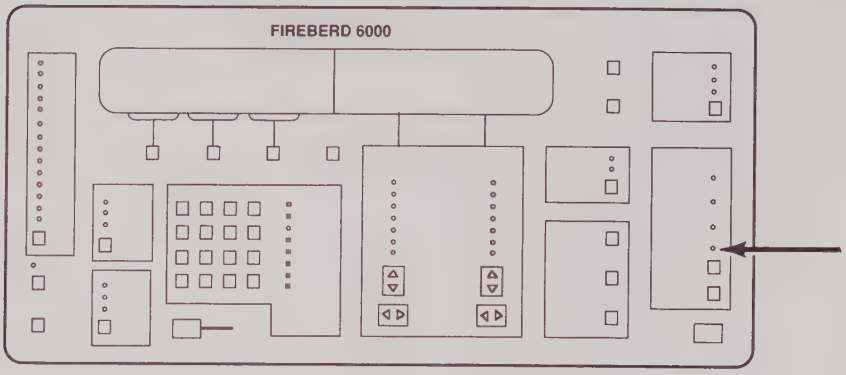
   d. Changing the position of the ANALYSIS MODE switch.

   e. Changing the interface selection.

(RL)

(RL)

Remote Loopback (RL) Indicator



Front-Panel Component-Type:

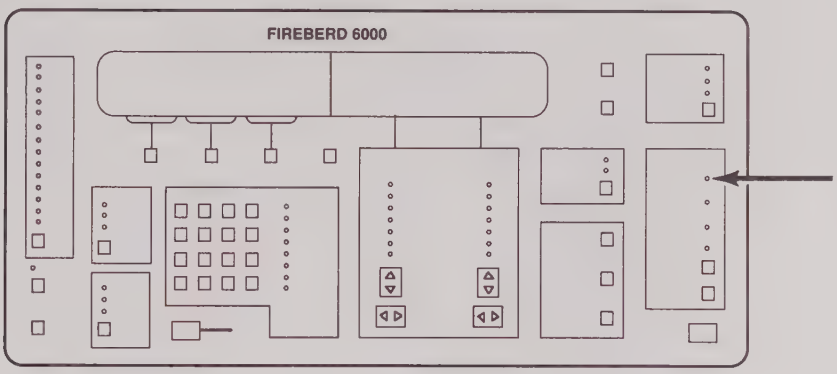
Discrete LED indicator with adjacent label (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DCE, the (RL) LED indicator shows the state of the Remote Loopback (RL) line. When the indicator is illuminated, the RL line is enabled; otherwise, the RL line is disabled.

RLSD (RR) LED INDICATOR

Receive Ready (RR) Indicator



Front-Panel Component-Type:

Discrete LED indicator with adjacent label (see Section 3.2).

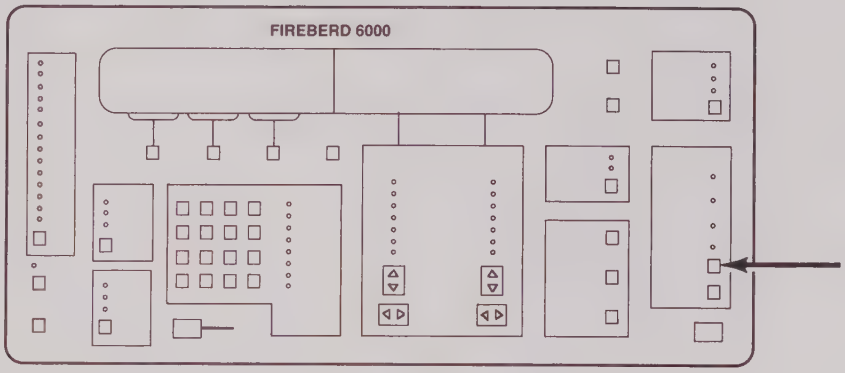
Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DTE, the RLSD (RR) indicator illuminates when the connecting DCE has enabled the Receive Ready (RR) line. When the RLSD (RR) indicator is not illuminated, the DCE's RR line is disabled.

RLSD (RR) SWITCH

RLSD (RR) SWITCH

Receive Ready (RR) Line Control



Front-Panel Component-Type:

Single-function Switch (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DCE, the RLSD (RR) switch controls the state of the Receive Ready (RR) line. When the switch is illuminated, the RR line is enabled; otherwise, the RR line is disabled.

Notes:

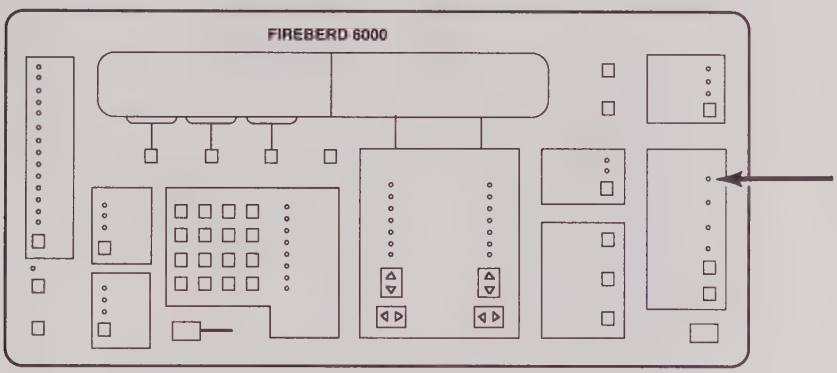
1. The enabling of signaling leads is an activity normally associated with *out-of-band flow control*. In out-of-band flow control, data transmission takes place only when certain signaling leads are placed in the ON state (i.e., enabled). In either DTE or DCE emulation, data transmission may be conditioned upon the enabling of any or all of these leads:

Signaling Lead:	Described on Page:
CTS	3-12
DSR (DM)	3-20/3-21
DTR (TR)	3-22/3-23
RLSD (RR)	3-39/3-40
RTS	3-41/3-42

2. Auxiliary Function 08 (OUT-BAND FLOW) allows the user to specify which signaling leads must be in the ON state for data transmission to take place. This auxiliary function is fully described in Section 4.

RTS LED INDICATOR

Request To Send (RTS) Indicator



Front-Panel Component-Type:

Discrete LED indicator with adjacent label (see Section 3.2).

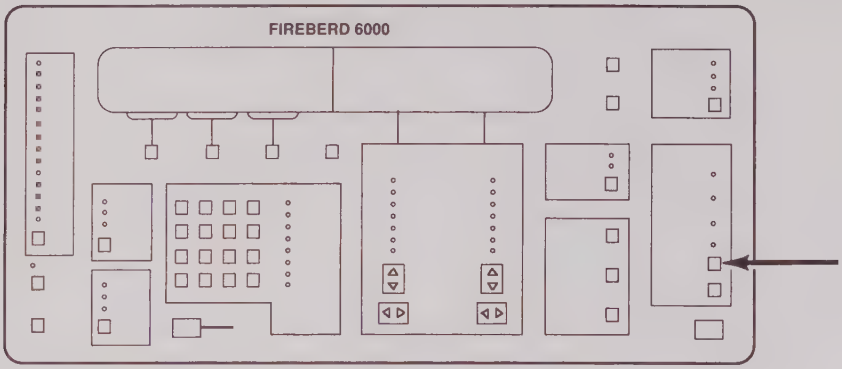
Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DCE, the RTS indicator illuminates when the connecting DTE has enabled the Request To Send (RTS) line. When the RTS indicator is not illuminated, the RTS line is disabled.

RTS SWITCH

RTS SWITCH

Request To Send (RTS) Line Control



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DTE, the RTS switch controls the state of the Request To Send (RTS) line. When the switch is illuminated, the RTS line is enabled; otherwise, the RTS line is disabled.

Notes:

1. The enabling of signaling leads is an activity normally associated with *out-of-band flow control*. In out-of-band flow control, data transmission takes place only when certain signaling leads are placed in the ON state (i.e., enabled). In either DTE or DCE emulation, data transmission may be conditioned upon the enabling of any or all of these leads:

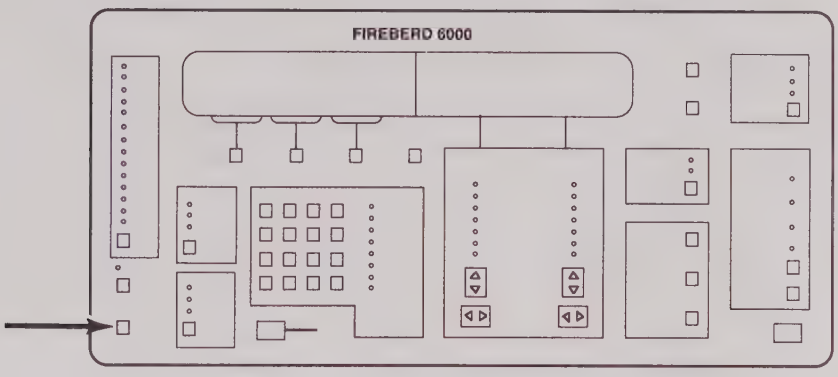
Signaling Lead:	Described on Page:
CTS	3-12
DSR (DM)	3-20/3-21
DTR (TR)	3-22/3-23
RLSD (RR)	3-39/3-40
RTS	3-41/3-42

2. Auxiliary Function 08 (OUT-BAND FLOW) allows the user to specify which signaling leads must be in the ON state for data transmission to take place. This auxiliary function is fully described in Section 4.

SELF LOOP

SELF LOOP

Enter/Exit Self-Loop Mode



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

The SELF LOOP switch changes the FIREBERD 6000's mode of operation from full-duplex to self-loop or vice versa. In self-loop mode, the instrument's transmit data and clock leads are connected to the receive data and clock leads, establishing an internal loop for testing the FIREBERD and its selected interface. Additionally, self-loop mode permits the user to disconnect the FIREBERD from the circuit under test without removing cables from the interface.

Notes:

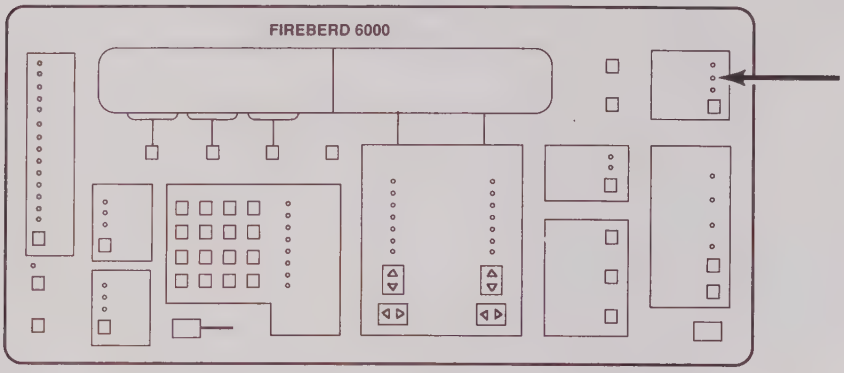
1. When the FIREBERD 6000 is in self-loop mode, the red LED within the SELF LOOP switch is illuminated. To return to full-duplex mode, press and immediately release the switch.

2. Out-of-band flow control (controlled in Auxiliary Function 8) and single transmit mode (controlled in Auxiliary Function 4) are disabled in self-loop mode.

SP

SP

Space Indicator



Front-Panel Component-Type:

Discrete LED with adjacent label (see Section 3.2).

Purpose:

The SP indicator illuminates when a Space (i.e., zero) is detected in the received data.

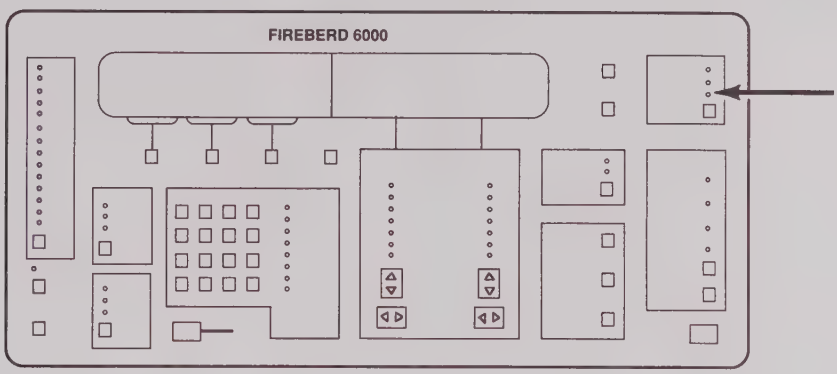
Notes:

1. Although not always apparent to the naked eye, the MK and SP indicators illuminate at different times (i.e., the SP indicator is off when a Mark is detected and vice versa).

SYNC

SYNC

Pattern Synchronization Indicator



Front-Panel Component-Type:

Discrete LED indicator with adjacent label (see Section 3.2).

Purpose:

When conducting an out-of-service test, the SYNC indicator illuminates when the FIREBERD 6000's receiver achieves pattern synchronization. When monitoring live data, this indicator illuminates to show that a signal is present.

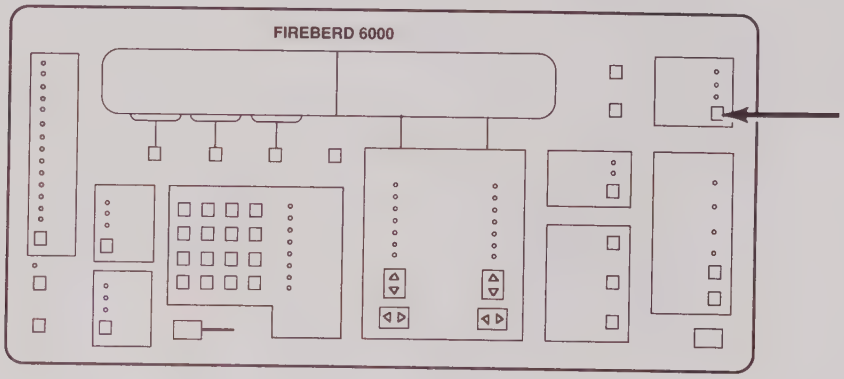
Notes:

1. The SYNC indicator is controlled by the receiver synchronization criteria described in Section 5 of this manual.

SYNC LOST

SYNC LOST

Detect Synchronization Loss



Front-Panel Component-Type:

Single-function switch (see Section 3.2).

Purpose:

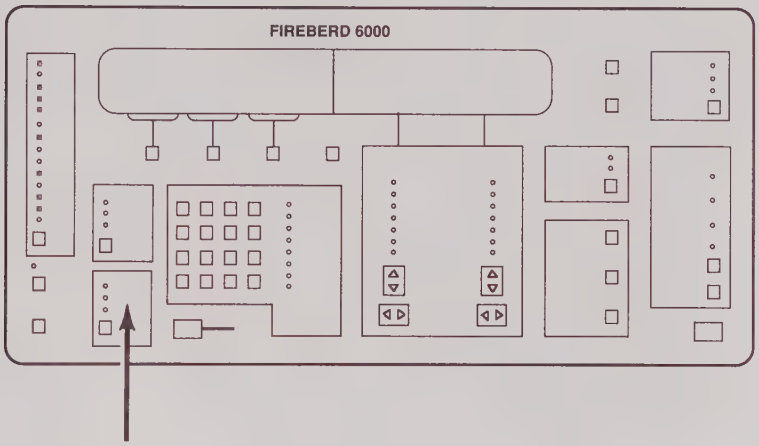
The SYNC LOST switch indicates a loss of synchronization by the receiver.

Notes:

1. When a synchronization loss is detected, the SYNC LOST switch immediately illuminates and remains so even if synchronization is reacquired. By remaining illuminated, the switch acts as a history indicator that signals the occurrence of a synchronization loss sometime during the test. The switch remains illuminated until it is pressed or the test is restarted.

TIMING MODE

Select a Mode of Signal Timing



Front-Panel Component-Type:

Electronic slide switch (see Section 3.2).

Purpose:

The TIMING MODE switch controls the type of transmit and receive timing required for any out-of-service test.

Select:	To:
SYNC	Choose synchronous timing. In synchronous transmission, the time interval between data bits is fixed and based on a controlled clock rate. To provide the required timing information to the receiving equipment, the clock signal is transmitted with the data (on a separate lead).
ASYNC	Choose asynchronous timing. In asynchronous transmission, the data is divided into characters containing 5 to 8 bits each. Each character is "framed" with start and stop bits, and may also include a parity bit. No clock signal accompanies the data.
RECOVD	Choose recovered timing. In this mode, the receiver achieves bit synchronization from the transitions in the data stream. If present, the receive clock is ignored. **NOTE:** The Clock Recovery Option (Option 6004) is required to recover timing from synchronous signals to 520 kb/s.

Notes:

1. When the Clock Recovery Option is not installed, RECOVD is not available when scrolling through the switch positions.

TIMING MODE

TIMING MODE

Select a Mode of Signal Timing (Continued)

Notes (continued):

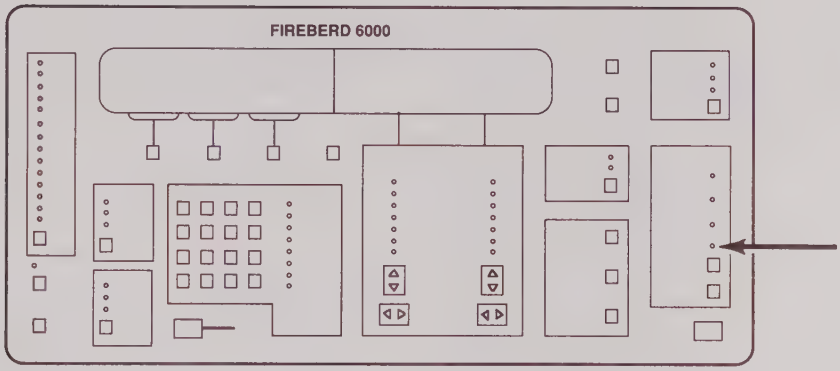
2. When using a data interface where none of three choices apply, the TIMING MODE switch will not operate. These interfaces include:

Model:	Interface:
30608	CCITT G.703 64 kb/s Interface
30609	CCITT G.704 2048 kb/s Interface
30481	DS0/DS0A Interface
30678	DDS DS0A/B Interface
41131	DDS Local Loop Interface
40540	DS1/T1/D4/ESF/SLC-96 Interface
40460	DS1/T1/D4/ESF Interface
41075	ISDN S/T TE Interface

3. Certain interfaces can only operate in one timing mode; in such instances, the TIMING MODE switch "freezes" on that selection (i.e., the user cannot change it). Additionally, the TIMING MODE switch will "lock out" the invalid value when an interface can only operate in two of the three timing modes.

(TM) (TM)

Test Mode (TM) Indicator



Front-Panel Component-Type:

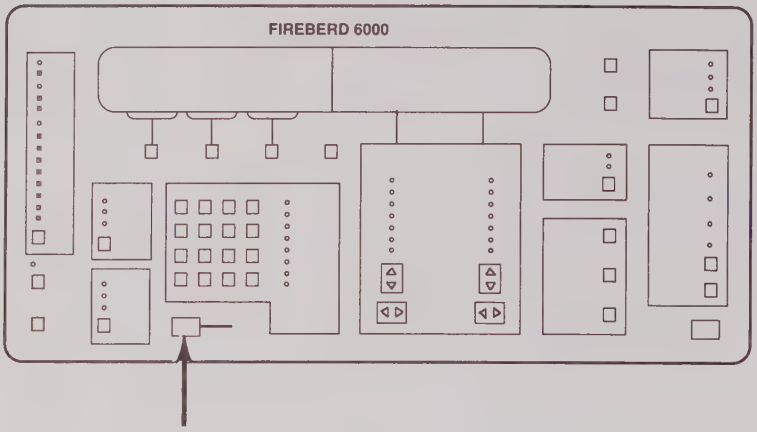
Discrete LED indicator with adjacent label (see Section 3.2).

Purpose:

When a data interface such as RS-232, V.35, or RS-449 is selected, and the FIREBERD 6000 is emulating a DTE, the (TM) LED indicator shows the state of the Test Mode (TM) line. When the indicator is illuminated, the TM line is enabled; otherwise, the TM line is disabled.

VOLUME **VOLUME**

Control the Audio Level of the Tone Generator



Front-Panel Component-Type:

Slide control switch.

Purpose:

The VOLUME control determines the audio level of the tone generated by the FIREBERD during certain events (e.g., power-up). To increase the audio volume, move the slide control to the right.

Notes:

1. The FIREBERD 6000's tone generator features three distinct audible signals based on specific events, as follows:

TONE:	OCCURS DURING:
One short "beep"	An invalid keypad entry.
	An errored second when ERR EAS or BIT ERRS are displayed.
Two-tone "beep"	A synchronization loss.
Three-tone "beep"	Completion of a test interval when BER is displayed.

3.4 REAR PANEL

The FIREBERD 6000's rear panel hosts all the instrument's connections and the slot in which the modular data interfaces are installed. In addition to the test points and BNC connectors which provide signal access, several other rear-panel features are also available, as shown in Figure 3-2. The numbers which flag the items in the figure correspond to the numbered descriptions in the following paragraphs.

1. RS-232 PRINTER/CONTROLLER INTERFACE

The RS-232 Printer/Controller Interface is a female, 25-pin, D-type connector which is configured for asynchronous DCE operation. It is used to send information to a compatible printer for generating printouts of status messages, test results, and mainframe configurations. The interface is also used to connect a device to the FIREBERD 6000 for remote control operation, which can be accomplished using a dumb terminal or a computer with communications software. Section 7 fully describes the FIREBERD 6000's printer interface; the *FIREBERD 6000 Remote Control Handbook* fully describes the instrument's remote control interface.

2. IEEE-488 INTERFACE SLOT

This slot allows the optional IEEE-488 interface to be inserted in the FIREBERD 6000. When this option is not installed, the slot is covered by a blank-off plate.

3. FUSE AND VOLTAGE SELECTOR

The fuse and voltage selector is a small card near the power plug that is used to choose whether the FIREBERD 6000 operates on 115 or 230 Volts Alternating Current (VAC). To select a voltage, remove, rotate, and reinstall the card with the appropriate voltage showing. Any time that the voltage is changed, the fuse must be replaced with another fuse of the proper style and rating. See Section 2.6 for detailed information on voltage selection and fuse replacement.

4. FAN

A fan mounted on the rear panel permits proper cooling and ventilation of the internal components. It is always in operation when the FIREBERD is turned on, and cannot be operated independently. The fan is protected by a screen which should be checked periodically for dirt or blockage. See Section 12.2.2 for instructions on fan screen maintenance.

5. TEST POINTS

A variety of TTL-level test points are provided for measurement and synchronization purposes, as follows:

RCVR CLK - The RCVR CLK output is a buffered version of the clock used by the receiver section of the instrument. Normally, the data of the RCVR DATA test point is valid on the rising edge of the RCVR CLK signal. This output is not valid with asynchronous timing.

RCVR DATA - The RCVR DATA output is a buffered version of the data that is sent to the FIREBERD's receiver. A LOGIC HIGH represents a received Mark: a LOGIC LOW represents a received Space.

GEN CLK - The GEN CLK output is a buffered version of the clock used by the generator section of the instrument. Normally, the data at the GEN DATA test point is valid on the rising edge of the GEN CLK signal. This output is not valid with asynchronous timing.

GEN DATA - The GEN DATA output is a buffered version of the generator data being sent to the data interface. A logic high represents a transmitted Mark; a logic low represents a transmitted Space.

GEN PATT SYNC - The GEN PATT SYNC output provides a one-bit-wide, high-going pulse once per generated pseudorandom pattern. For example, if the DATA switch is set to the 511 position, one GEN PATT SYNC pulse occurs for every 511 data bits generated. If the DATA switch is set to the PRGM position, one pulse is provided for every repetition of the 3- to 24-bit pattern. If the DATA switch is set to the MK or 1:1 positions, one pulse is provided every 24 generator data bits. This output is not valid with asynchronous timing.

RCVR PATT SYNC - The RCVR PATT SYNC output provides a one-bit-wide, high-going pulse once per received pseudorandom pattern after the receiver has achieved synchronization. When synchronization to a PRGM pattern is achieved, one pulse is provided for each repetition of the 3- to 24-bit pattern. When synchronization is achieved to a Mark or 1:1 pattern, one pulse is provided for every 24 data bits received. This output is not valid with asynchronous timing.

ERROR - The ERROR output provides a half-bit-wide pulse each time an error is detected in the received data. This output is not valid with asynchronous timing.

SYNC - The SYNC output is at a LOGIC LOW when the receiver is not in synchronization with the received pattern, and is at a LOGIC HIGH when receiver synchronization has been achieved. This output is not valid with asynchronous timing.

DELAY START - The DELAY START input is the delay start-of-measurement signal, controlled by Auxiliary Function 31 (using the TP softkey). Either the rising or falling edge of the signal may be selected.

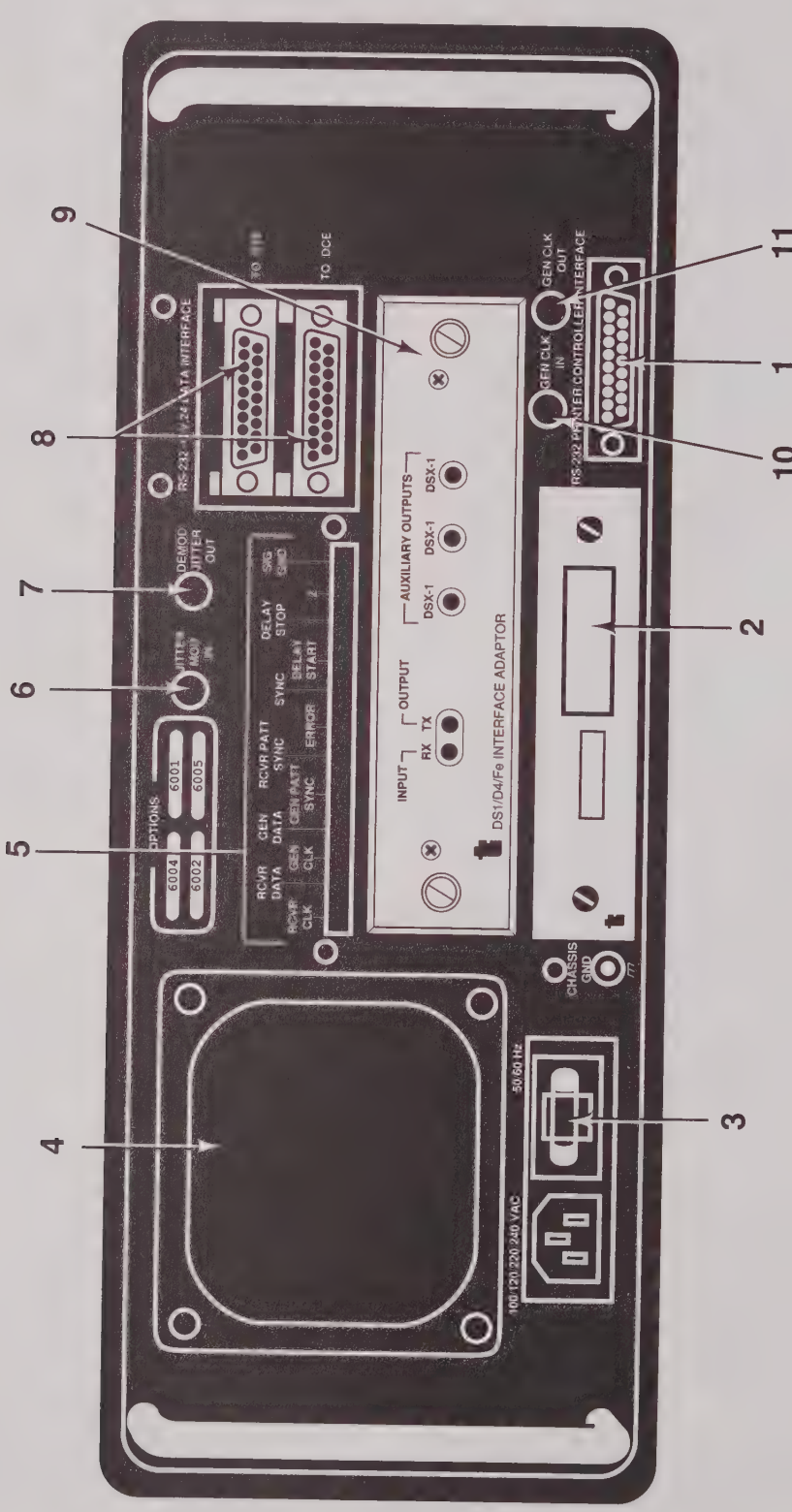


Figure 3-2
FIREBERD 6000 Rear Panel

DELAY STOP - The DELAY STOP input is the delay end-of-measurement signal, controlled by Auxiliary Function 31 (using the TP softkey). Either the rising or falling edge of the signal may be selected.

Z - The Z test point provides external indications of alarm conditions and status. It may be turned off or on by remote control.

SIG GND - This test point is connected to signal ground.

6. JITTER MOD IN

The JITTER MOD IN is a BNC connector that applies only when the DS1 Jitter Generation option is installed and an interface with jitter capability is used (See Section 9). Any signal presented to this connector may be selected to jitter the transmitted T1 or G.703/G.704 signal correspondingly.

7. DEMOD JITTER OUT

The DEMOD JITTER OUT is a BNC connector that applies only when the DS1 Wideband Jitter Measurement option is installed in the FIREBERD and the DS1/D4/Fe Data Interface is used. Jitter on the received T1 signal is extracted and sent to this connector for monitoring. This output can drive a 50-ohm load, and is calibrated at 10 Unit Intervals (UIs) per volt.

8. RS-232-C/V.24 DATA INTERFACE DTE/DCE CONNECTORS

These two female, 25-position, D-type connectors allow separate DTE and DCE operation for the FIREBERD 6000's built-in RS-232-C/V.24 data interface. The DCE (upper) connector is designed to connect to a DTE under test; the DTE (lower) connector is designed to connect to a DCE under test.

9. DATA INTERFACE SLOT

This slot hosts any modular interface that can be inserted into the FIREBERD 6000. Additionally, the data interface slot can connect the instrument to as many as two ISU-6000 switching units, each of which holds as many as four modular interfaces.

10. GEN CLK OUT

GEN CLK OUT is a BNC connector that provides a buffered version of the generator clock signal. This output is a TTL signal capable of driving a 50-ohm load.

11. GEN CLK IN

GEN CLK IN is a BNC connector that permits an external clock source to be connected to the FIREBERD 6000. In such instances, the instrument GEN CLK switch is set to the BNC position. The FIREBERD accepts a sine- or square-wave signal of at least 1.5 volts peak-to-peak from 50 Hz to 15 MHz. GEN CLK IN has a built-in termination of 50 ohms.

SECTION 4
THE FIREBERD 6000'S MENU FACILITIES

4.1 SECTION SUMMARY

This section describes the components of the FIREBERD 6000's menu facility.

4.2 THE FIREBERD 6000'S MENU FACILITY

The FIREBERD 6000's menu facility is the center of activity when configuring the instrument for any test you wish to run. Its three primary components are:

- The MENU switch
- The MENU display and softkeys
- The MENU keypad

4.2.1 The MENU Switch

The MENU switch is used to select any of the instrument's eight set-up menus for display. These menus are provided for:

- Functions which have a large number of configurable parameters
- Functions that change with data interfaces or options
- Functions requiring numeric or hexadecimal entries

Each function associated with the MENU switch is fully described in Section 4.3.

4.2.2 The MENU Display and Softkeys

The MENU display shows the functional menu that is currently selected (by the MENU switch). The three MENU softkeys located below the display area control menu movement and selection.

To illustrate how the display and softkeys actually work, Figure 4-1 depicts a tree of the functions associated with the PRINT EVENT menu.

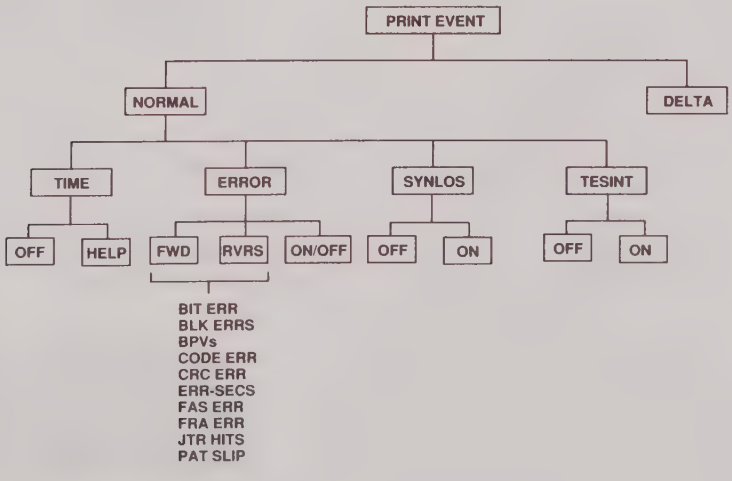
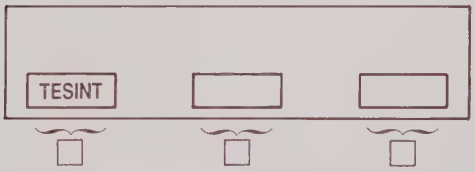


Figure 4-1
PRINT EVENT Menu Tree

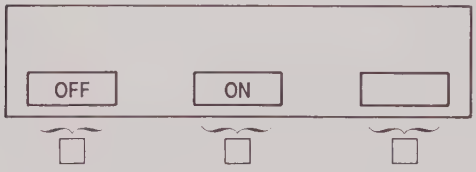
When PRINT EVENT is selected, the top of the PRINT EVENT menu tree appears in the MENU display. When a softkey is not used, the display area above the bracket is blank.

Pressing the softkey under NORMAL selects the functions associated with standard print events. The MENU display then shows the first three choices at the NORMAL menu's next level.

The MORE key (located to the right of the MENU softkeys) is illuminated when more than three choices are available at the current menu level. When pressed, the next set of softkey labels are displayed.



When the softkey under any of these four menu choices is pressed (TIME, ERROR, SYNLOS, TESINT), the PRINT EVENT menu moves to its next level. For example, when the TESTINT softkey is pressed, the ON and OFF softkeys appear in the display.



If you desire, you can initiate a printout at the end of each test interval by pressing the ON soft key. You can also return to the previous level in the menu at any time by pressing the Up-Arrow ▲ key located on the MENU keypad. If desired, the ENTER key can be used to return to the top level of the menu.

4.2.3 The MENU Keypad

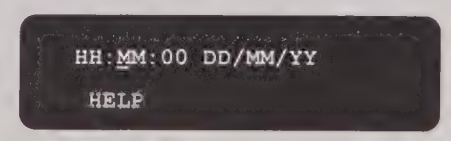
The MENU keypad is used with functions that have a range of values that are too large to be represented by a softkey. The keypad is also used to move backward through any menu tree and (where applicable) for cursor manipulation. Table 4-1 describes the components of the MENU keypad.

Table 4-1
The MENU Keypad

Key:	Function:
0-9	Numeric entry
Period (.)	Floating decimal point entry (e.g., synthesizer frequency)
SHIFT	Access hexadecimal digits A-F (labeled in blue). For example, to enter an A: 1. PRESS AND RELEASE the SHIFT key. 2. Press the blue-labeled A key.
ENTER	Terminate and implement keypad-entered data. ENTER can also be used to move to the top leveL of any menu.
▲	Move to previous level in the menu.
▶ ◀	Cursor manipulation for menus where all or part of a setting can be changed. ▶ Moves cursor to the right. ◀ Moves cursor to the left.

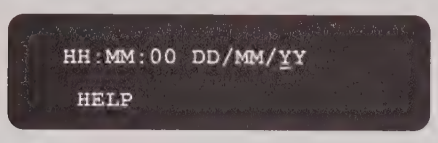
Cursor Manipulation

Cursor manipulation is required for menu functions that have fields of data, such as Auxiliary Function 60's time and date displays shown below.

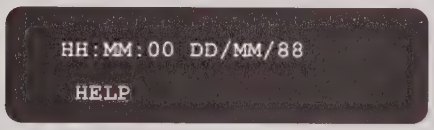


Note that the cursor is currently positioned under the first digit in the minute (MM) field. To move the cursor to the hour field (HH), press the key; to move the cursor to the right,

press the ▶ key. For example, to change the year (YY), position the cursor under the YY field using the ▶ key:



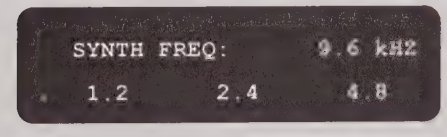
The current year is entered using the appropriate numbers on the keypad; all other fields are unchanged:



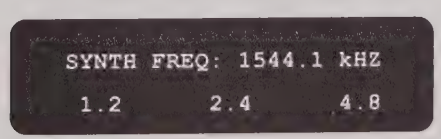
To implement the new setting, press the ENTER key.

Entering a Number Without a Cursor

Many numeric entries do not have fields and, therefore, do not require a cursor. For example, when SYNTH FREQ is the currently selected menu, the display may appear as follows:



To enter a new frequency (e.g., 1544.1 kHz), type the number 1544.1 using the MENU keypad. As soon as the first digit is pressed, the previous display is blank; the new numbers appear as they are entered. Note that the previous setting (9.6) is still in effect until the ENTER key is pressed. The display then reads:



4.3 MENU REFERENCE

This section fully describes each of the menus associated with the MENU switch (Table 4-2).

Table 4-2
MENU Switch Functions

SELECT:	TO:
SYNTH FREQ	Select a synthesizer frequency.
INTF SETUP	Select and configure either the built-in RS-232 interface or the modular interface installed in the rear panel of the FIREBERD 6000. Required for all testing.
TEST INTERVAL	Select a test interval. The test interval can be set to a fixed period of time or a fixed bit length. Required for all testing.
CHAR FORMAT	Set the asynchronous character format (i.e., start, data, parity, and stop bits). Required for asynchronous testing.
JITTER	Configure jitter generation and analysis options. (The FIREBERD 6000's jitter capabilities are optional. When not installed, the message: **Option not installed** appears in the MENU display.)
PRINT EVENT	Set print event criteria. Test results can be sent to an external printer at the end of each test interval or upon the occurrence of specific events. Required when hard-copy test results are desired.
RECALL/STORE	Store and recall up to 10 different test configurations.
AUXILIARY	Set up any of the FIREBERD 6000's additional configurable functions.

SYNTH FREQ

SYNTH FREQ

Select a Synthesizer Frequency

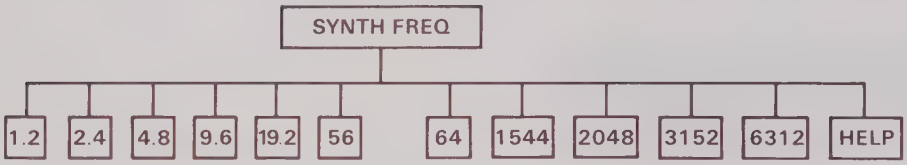


Figure 4-2
SYNTH FREQ Menu

Purpose:

The SYNTH FREQ menu sets the frequency when using the FIREBERD 6000's built-in synthesizer. This menu is required when the FIREBERD is selected as the source of signal timing (i.e., the GEN CLK switch is set to the SYNTH position) and when the asynchronous or recovered timing modes are selected.

A synthesizer frequency can be selected from the set available in the menu (see Figure 4-2); however, any frequency can be specified using the MENU keypad. In such instances, frequencies are entered in kHz and must be within the range of .05-15000 kHz. When a frequency outside of this range is entered, the FIREBERD recognizes the entry as illegal and restores the previous setting without disrupting the test in progress. Please note that a newly specified frequency is not current until the ENTER key is pressed.

Notes:

1. A frequency may have four or five significant digits. If the first two digits are within the range 16-99, four digits may be entered; if the first two digits are within the range 10-15, five digits may be entered.

2. The range and format of any entered frequency is not checked until the ENTER key is pressed.

3. Auxiliary Function 32 enables the user to program the MENU softkeys so that commonly used frequencies (other than the factory settings shown in Figure 4-2) are available as SYNTH FREQ menu selections. See Table 4-4 for a description of this capability.

4. When in asynchronous timing mode (i.e., the TIMING MODE switch is set to the ASYNC position), and the FIREBERD's synthesizer is the source of signal timing, then the frequency specified can be no more than 20 kHz; in recovered timing mode, the frequency specified should be no more than 520 kHz.

5. When the jitter generator is enabled, the message **Synth defaults to xxx kHz with jit gen** appears in the MENU display. This means that any change in synthesizer frequency is ignored until the jitter generator is turned off or a new interface is selected.

6. When the HELP softkey is pressed, the message **Enter frequency in kHz: .05-15000** appears in the MENU display for approximately three seconds, or until another key is pressed.

INTF SETUP

Select An Interface

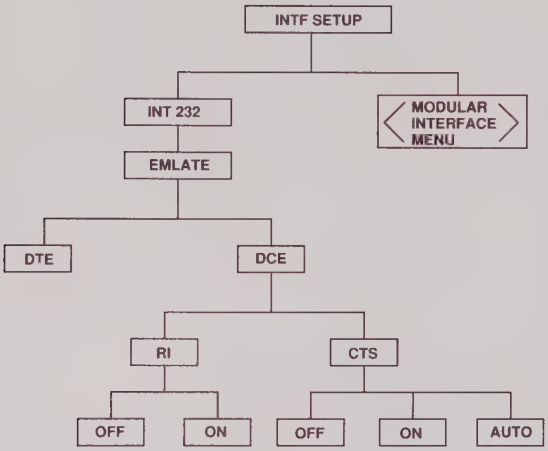


Figure 4-3
INTF SETUP Menu

Purpose:

The INTF SETUP menu is used to select and configure either the built-in RS-232 interface or the modular interface installed in the rear panel of the FIREBERD 6000. This menu applies when running any FIREBERD 6000 test.

Since all interfaces have unique configuration requirements, no two interface menus are exactly the same. Thus, when the RS-232 interface is selected, the user must configure the FIREBERD for DTE or DCE emulation by stepping through the menu shown in Figure 4-3. But if, for example, an installed T1 interface is selected, the menus offer entirely different configuration choices (e.g., framing, coding, etc.). See the appropriate manual for the menus that apply to your chosen modular interface.

Notes:

1. The built-in RS-232 interface is fully described in Section 8 of this manual. Section 1.3 lists the modular interfaces that are currently available for use with the FIREBERD 6000.

2. When no modular interface is installed in the rear panel of the FIREBERD 6000, the softkey label normally reserved for the installed interface is blank.

3. If the selected modular interface is removed, the word **EMPTY** is displayed in lieu of the interface name at the top of the menu.

TEST INTERVAL **TEST INTERVAL**

Select A Test Interval

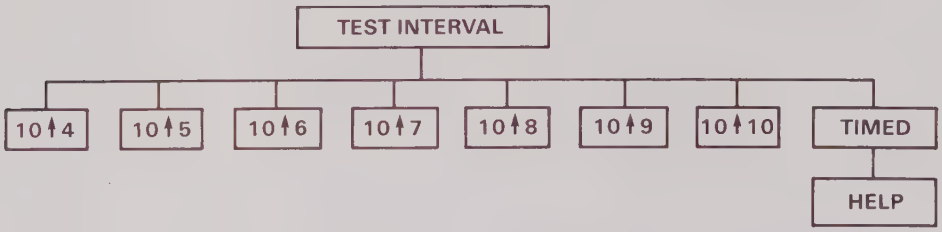


Figure 4-4
TEST INTERVAL Menu

Purpose:

As its name suggests, this menu is used to select a test interval. It applies when running any FIREBERD 6000 test.

The test interval can be set to a fixed bit length or a fixed period of time (Figure 4-4). Fixed bit lengths of 10^4 through 10^{10} can be selected using the appropriate softkey. When the TIMED softkey is pressed, a cursor can be used to specify a time interval within a one second to 24 hour range. When a value outside of this range is specified, the FIREBERD recognizes the entry as illegal and restores the previous value without disrupting the test in progress. Please note that a newly specified test interval is not current until the ENTER key is pressed.

Notes:

1. When the ANALYSIS MODE switch is set to CONTINUOUS, the test interval determines the length of any measurement that is cyclical in nature (e.g., BER or BPV Rate); results that are not cyclical accumulate indefinitely. When the ANALYSIS MODE switch is set to SINGLE, the FIREBERD accumulates all results until the test interval has expired; at such time, the flashing message **Test Complete** appears in the ANALYSIS RESULTS display.

2. When the HELP softkey is pressed, the message **Enter time interval, 24 hr max, HH:MM:SS** appears in the MENU display for approximately three seconds, or until another key is pressed.

CHAR FORMAT

Set Asynchronous Character Format

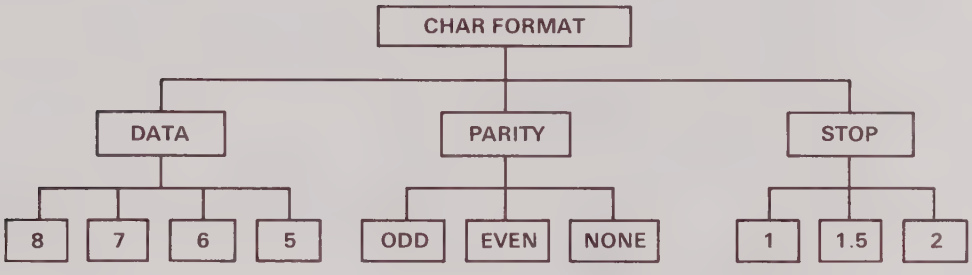


Figure 4-5
CHAR FORMAT Menu

Purpose:

The CHAR FORMAT menu sets the asynchronous character format. It always applies when running an asynchronous test (i.e., when the TIMING MODE switch is set to the ASYNC position).

As shown in Figure 4-5, the CHAR FORMAT menu permits the configuration of data bits, parity bits, and stop bits. Using the appropriate softkeys, the user may select 5, 6, 7, or 8 data bits; odd, even, or no parity; and 1, 1.5, or 2 stop bits.

JITTER

JITTER

Set Jitter Parameters And Display Spectral Analysis

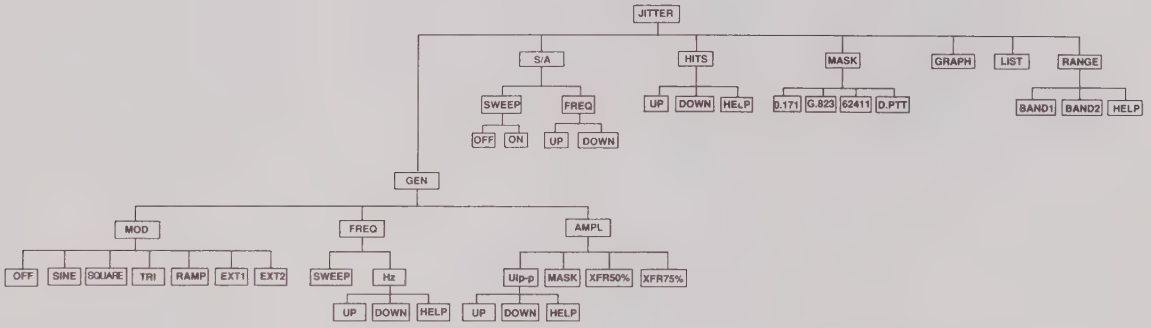


Figure 4-6
T1 JITTER Menu

Purpose:

The JITTER menu is used to configure jitter parameters and display spectral analysis. This function is fully described in Section 9.

Notes:

1. The FIREBERD 6000's jitter capabilities are optional. When not installed, the message **Option not installed** appears in the MENU display for approximately three seconds, or until another key is pressed.
2. When the jitter option is installed, and a modular interface without such capability is selected, the message **Interface and jitter not compatible** appears in the MENU display for approximately three seconds, or until another key is pressed.
3. The FIREBERD 6000 also offers jitter testing for G.703 circuits and equipment. The menu for G.703 jitter is shown in Section 9.

Set Print Event Criteria

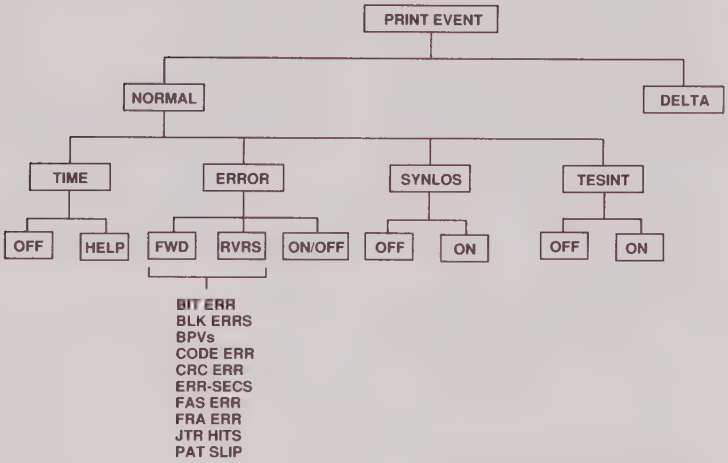


Figure 4-7
PRINT EVENT Menu

Purpose:

The PRINT EVENT menu is used to specify the criteria for sending test results to an external printer.

The PRINT EVENT menu can be set in two basic modes: DELTA and NORMAL (see Figure 3-7). When DELTA is selected, a delta print is generated at the end of each test interval. A Delta print is a hard copy of those results accumulated during the most recent test interval, as opposed to those results that have accumulated since the start of the test. If the NORMAL softkey is pressed, cumulative results prints are offered based on *one or more* specific events: a time interval, an error, a synchronization loss, and a test interval.

The TIME softkey permits hard copy results to be printed at a time interval within the range 1-1440 minutes. The specific value is entered using the MENU keypad; the OFF softkey "turns off" time as a print criteria.

PRINT EVENT

Set Print Event Criteria

The ERROR softkey permits hard copy test results to be printed on the occurrence of one or more of the following errors:

- Bit errors (BIT ERRS)
- Block errors (BLK ERRS)
- BPVs
- Code errors (CODE ERR)
- CRC errors (CRC ERR)
- Severely errored seconds (ERR-SES)
- FAS errors (FAS ERR)
- Frame errors (FRA ERR)
- Jitter hits (JTR HITS)
- Pattern slips (PAT SLIP)

The FWD softkey permits forward movement through the error menu shown above; the RVRS softkey permits backward movement; the current selection is shown in the upper left corner of the display. The ON/OFF key is used to select or reject an error as print criteria; the current setting is shown in the upper right corner of the display.

SYNLOS permits a printout to be generated when pattern synchronization is lost. In such instances, the test results that are sent to the printer are those accumulated from 2 to 4 seconds preceding the synchronization loss. The OFF and ON softkeys turn this print criteria off and on, respectively.

TESINT permits a printout to be generated at the end of the current test interval. The OFF and ON softkeys turn this print criteria off and on, respectively.

NOTE: The PRINTER switch must be turned ON for printing to occur.

RECALL/STORE

Store/Recall Test Configurations

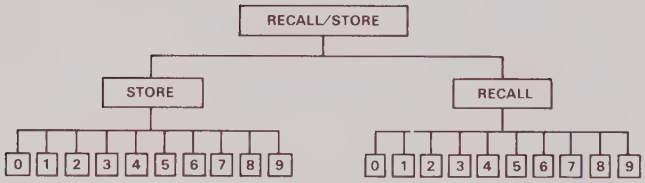


Figure 4-8
RECALL/STORE Menu

Purpose:

The RECALL/STORE menu permits as many as 10 frequently used test configurations to be stored and automatically recalled for future use. This feature saves set-up time by permitting all switch and interface selections for a specific test to be implemented by a single softkey.

For example, to store the FIREBERD's current configuration, press the STORE softkey, then select an ID number (0-9), again using the appropriate softkey. When desired, the saved configuration can be recalled by pressing the RECALL softkey, followed by the softkey for the program's ID number.

Notes:

1. Any program's ID number may also be entered using the keypad.

AUXILIARY **AUXILIARY**

Set 29 Configurable Functions

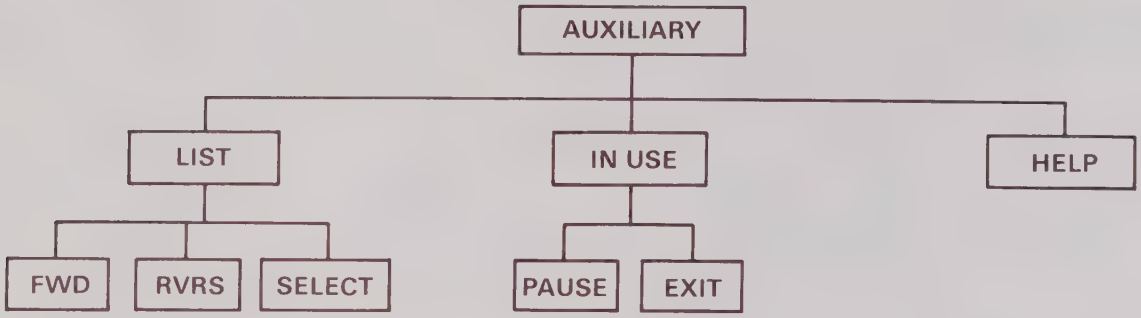


Figure 4-9
AUXILIARY Menu

Purpose:

The AUXILIARY menu allows access to 29 additional configurable functions, as follows:

Aux Function	Name
1	Generator clock polarity
2	Receiver clock polarity
3	Receiver action on synchronization loss
4	Single transmit
6	Generator data inversion
7	Receiver clock selection
8	Out-of-band flow control
9	In-band flow control
10	Synchronization loss threshold
11	I/O driver selection
30	Block length
31	Signal delay
32	Programmed synthesizer frequencies
33	Programmable patterns
34	Site identification
35	Results print content
36	Status print selection
37	Printout format
38	RS-232 print/control set-up
39	IEEE-488 print/control setup
40	Software version display
41	User message selection
42	Pre-sync loss results
43	Clear non-volatile memory
44	Histogram set-up
45	Synch acquisition threshold
46	Async data timeout
60	Time/date setting
99	Reset aux. functions to default states

The LIST softkey allows the user to display the name and number of each function in the auxiliary menu. When LIST is selected, the FWD softkey permits forward movement through the menu; RVRS permits backward movement; SELECT lets the user enter the currently displayed menu. Also note that any auxiliary function can be selected by entering its number on the MENU keypad and pressing the ENTER key.

Status-Select Auxiliary Functions

As a group, auxiliary functions 1-10 are known as *status-select auxiliary functions* (Table 4-3). This means that the potential status of each of these functions is reflected in their respective softkey labels. In all instances, the setting listed first is the default; a status-select auxiliary function is "in use" when it is set to any status other than the default. In such instances, the AUX FUNC IN USE label is illuminated. Additionally, the IN USE softkey displays those status-select auxiliary functions that are not set to their defaults.

NOTE: Status-select auxiliary functions are not applicable to all interfaces.

Table 4-4 describes non-status-select auxiliary functions.

Table 4-3
Status-Select Auxiliary Functions

Function:	Number:	Name:	Description:
Generator Clock Polarity	01	GEN CLK POL	NORMAL - Clock data phasing is per interface standard. INVERT - Clock data phasing is the inverse of the interface standard.
Receiver Clock Polarity	02	RCVR CLK POL	AUTO - Receiver clock data phasing is automatically detected, corrected, and maintained while error analysis is in progress. NORMAL - Clock data phasing is per interface standard. INVERT - Clock data phasing is the inverse of the interface standard.
Receiver Action On Synchronization Loss	03	ACT SYN LOSS	CLEAR - Clears all results counters and restarts test when synchronization is reacquired. HALT - Freezes all results for duration of synchronization loss. Test continues as soon as synchronization is reacquired. CONT - Continue to accumulate error analysis results while the receiver attempts to resynchronize. (Valid in SYNC and RECOVD timing modes only.)
Single Transmit	04	SINGLE TRANS	OFF - Transmits data continuously. ON - Transmits only one pattern or message each time the RESTART switch is pressed. This auxiliary function is disabled in self-loop mode.
Generator Data Inverter	06	GEN DATA INV	OFF - Transmitted data not inverted. ON - Transmitted data inverted.
Receiver Clock Select (DCE Emulation Only)	07	RCVR CLK SEL	AUTO - ST (a DCE output) is automatically elected if TT (a DCE input) is not present in the interface. TT - TT selected. ST - ST selected.
Out-of-Band Flow Control	08	OUT-BAND FLOW	OFF - Data transmission occurs regardless of signaling lead status. ON - Data transmission is conditioned upon the reception of one or more of the following signaling leads: TR, DM, RS, CS, and RR. CS is the default.

Table 4-3
Status-Select Auxiliary Functions (continued)

Function:	Number:	Name:	Description:
Out-of-Band Flow Control (continued)	08	OUT-BAND FLOW	This auxiliary function is disabled in self-loop mode.
In-Band Flow Control	09	IN-BAND FLOW	OFF - FIREBERD does not respond to XON and XOFF characters in the data received. (Asynchronous transmission is not affected.) ON - FIREBERD scans the incoming data for XON and XOFF characters and responds accordingly. Defaults XON to 11H and XOFF to 13H. This auxiliary function applies to asynchronous USER and FOX messages only.
Sync Loss Threshold	10	SYNC LOSS THR	Thresholds for SYNC and RECOVD timing modes are: MED - Declare sync loss when 250 bit errors are counted in less than 1000 bits. LOW - Declare sync loss when 100 bit errors are counted in less than 1000 bits. HIGH - Declare sync loss when 20,000 bit errors are counted in less than 100,000 bits. The settings for ASYNC timing mode are: LOW and MED - Declare sync loss when 30 character errors are counted in less than 60 received characters. HIGH - Declare sync loss when 20,000 bit errors are counted in less than 100,000 bits.

Table 4-4
Non-Status-Select Auxiliary Functions

Function:	Number:	Name:	Description:
I/O Driver Select	11	IO DRIVER SEL	SELECT - Sets the FIREBERD for both printing and remote control in any combination of the following: Remote Control: 232, 488, None. Printing: 232, 488, Remote, None.
Block Length	30	BLK LEN	Select the block length. The allowable range is 100 - 1,000,000 bits.

Table 4-4
Non-Status-Select Auxiliary Functions (continued)

Function:	Number:	Name:	Description:
Signal Delay	31	DELAY	Set up the FIREBERD for signal delay timing. The start timing and stop timing signals and edges are selected with this function. See Section 6.4 for detailed information on setting up for delay timing. **NOTE:** The start and stop parameters that reference signaling leads are only valid for interfaces that use these signals.
Program Common Frequencies	32	COMMON FREQ	Program the most commonly used frequencies as softkey settings for the SYNTH FREQ function of the MENU switch.
Programmable Pattern	33	PATTERN	Program and edit a 3- to 24-bit data pattern, to be used when the DATA switch is set to the PRGM position. The order of data bits transmitted is left-to-right on the display. When this auxiliary function is selected, the pattern editor is in "exchange" mode. This means that any binary digits entered overwrite the digit at the cursor. Use the INSERT softkey to toggle in/out of insert mode. In insert mode, digits are inserted at the cursor without overwriting any others. Digits may be entered at the end of the pattern in either mode. The DELETE softkey deletes the digit at the cursor. The ▶ and ◀ keys on the MENU keypad are used to position the cursor. The ENTER key is used to save and implement all changes made to the pattern. The ▲ key causes the FIREBERD to return to the unedited version of the pattern.
Site Identification	34	SITE ID	Identify a site when the FIREBERD is used in a specific network. The site ID is entered by positioning the cursor under each "digit" (using the ▶ and ◀ keys on the MENU keypad) and using the UP or DOWN softkeys to select the desired ASCII character.
Results Print	35	RESULTS PRINT	Determine the content of a results printout. STD selects the standard printout (Table 4-5). The LONG print includes all applicable results. The CUSTOM print allows each result to be included (ON) or excluded (OFF). Note that each result is included in the printout only as long as it is applicable to the operating mode in use at the time of the printout.
Status Print Selection	36	STATUS PRINT	Enable (ON) or disable (OFF) the printing of individual status messages. When enabled, the status message is printed each time the status changes (if the printer is enabled via the OFF/ON switch in the PRINTER block); when disabled, the status message is not printed.

Table 4-4
Non-Status-Select Auxiliary Functions (continued)

Function:	Number:	Name:	Description:
Printout Format	37	PRNT FRMT	Specify the printout format, as follows: COLUMN - choose 20-, 40-, or 80-column printouts. TERM - choose carriage return-linefeed (CRLF), carriage return (CR), linefeed (LF), or no (NONE) line termination. MODE - choose SLOW (maximum 20 characters per second) or FAST print speed (full baud rate).
RS-232 Driver Set-up	38	232	Used to configure the RS-232 printer/remote controller interface. The display for this function appears as: 232: bbbb,d,pppp where bbbb is the baud rate: 110, 300, 600, 1200, 2400, 4800, 9600. d is the number of data bits: 7,8. pppp is the parity: ODD, EVEN, NONE.
IEEE-488 Address	39	488	View the current address of the IEEE-488 Printer/Remote control interface, as follows: 488: ADDR: 20 where 20 is the address of the controller (range: 0 - 31). Note that the controller is only addressable when Auxiliary Function 11 (I/O Driver Select) is used to specify IEEE-488 remote control; when IEEE-488 is specified for a printer, the message TALK appears in the display in lieu of an address.
Software Version	40	SOFTWARE VERSION	Display the current software version and the date the software was revised. SW Version: G (C) TTC, 12/17/90
User Message Selection	41	USER MESSAGE	Select from a series of patterns which are supplemental to those available through the DATA switch: 1:7, 3-IN-24, T1-1/6, T1-mW, and DDS-1/6. Each is described in detail in Section 3. Table 4-6 (available at the conclusion of this chapter) summarizes the usage requirements for each of these patterns.

Table 4-4
Non-Status-Select Auxiliary Functions (continued)

Function:	Number:	Name:	Description:
User Message Selection	41	USER MESSAGE	Long User Patterns (LUPs) Auxiliary Function 41 can also be used to enter or edit up to three patterns of up to 2048 characters each. Any of these patterns may be used when the DATA switch is set to the USER position. Characters are entered in hexadecimal format (0-9 and A-F) from the MENU keypad; the ▶ and ◀ keys are used to position the cursor. In the hexadecimal format, 2 digits are required to define a character; thus, the cursor is 2 digits wide. The INSERT softkey is used to insert characters without overwriting the existing ones. When not inserting, the characters entered overwrite the characters at the cursor. Characters may be added at the end of the user message in either case. The DELETE softkey deletes the character at the cursor. The display for this function is: xxxxxxxxxxxxxx*yyyy where xx is the user message and yyyy is the numerical position of the byte underlined by the cursor. After creating a message or editing an existing one, press the ENTER key to save and implement it.
Recall Pre-Sync Loss Results	42	PRE SYNC LOSS	Transfer the test results recorded from 2 to 4 seconds before a synchronization or power loss to the results display buffer. In such instances, an automatic display hold is performed, *and test results are automatically sent to a printer, if one is enabled.* If no sync or power loss has occurred since the test started, the message **Pre sync/ power loss results not available** is displayed.
Clear Non-Volatile RAM Settings	43	CLEAR NOVRAM	Clear the FIREBERD 6000 of its current settings for stored programs, patterns, and user messages. When selected, all settings are returned to their factory-set values. The user must verify this operation before it is actually performed.
Histogram Setup	44	HISTOGRAM	Select the results to be graphed and the scale to be used for histogram plots. See Section 7 for details on the histogram printout.
User Message Synchronization Threshold	45	USR SYN THR	Select the number of unerrored bytes within the user message that must be received before pattern synchronization is established. PATL specifies that the entire pattern length must be received unerrored to declare pattern syn-

Table 4-4
Non-Status-Select Auxiliary Functions (continued)

Function:	Number:	Name:	Description:
User Message Synchronization Threshold (continued)	45	USR SYN THR	chronization. The BYTE selection is used to specify a variable number of unerrored bytes (values between 10-2048 bytes) that must be received to declare pattern synchronization. This function only affects synchronous user messages.
Asynchronous Data Timeout	46	ASYNC TIMEOUT	Select the action taken when no data is received in asynchronous timing mode. ON forces a synchronization loss after 10 seconds have passed without receiving data; OFF does not force a sync loss under identical conditions.
Time/Date Set	60	TIME/DATE	Set the FIREBERD's time and date calendar. The display shows: HH:MM:00 DD/MM/YY When changing either the data or time, position the cursor under the field to be changed and enter the correct number from the keypad. All or part of the time/date may be modified. The hours are in 24-hour format and range from 00 to 24. Setting the minutes automatically sets the seconds to 00. The ENTER key implements the setting.
Clear Status	99	CLEAR FUNC IN USE	Reset the status-select auxiliary functions (Table 4-3) to their factory-set (i.e., default) states. When selected, the AUX FUNC in use panel label is turned off.

Table 4-5
Standard Printouts for Operating Modes

Asynchronous	Synchronous and Recovered	Pseudoternary Standard
SITE ID	SITE ID	SITE ID
Bit Errors	Bit Errors	Bit Errors
Average BER	Average BER	Average BER
BER	BER	BER
Blocks	Blocks	Error-Free Error Analysis Seconds
Block Errors	Error-Free Error Analysis Seconds	% Error-Free Seconds
Character Errors	% Error-Free Seconds	Error Analysis Seconds
Error-Free Erorr Analysis Seconds	Time/Date	Time/Date
Error Analysis Seconds	RCV BYTE	Violations
Time/Date	RCV CODE	Average Violation Rate
GEN FREQ	RCV FREQ	Violation Rate
Interface	GEN FREQ	Frame Errors
		Average Frame Error Rate
		Frame Error Rate
		CRC Errors
		Average CRC Error Rate

Table 4-5
Standard Printouts for Operating Modes (continued)

Pseudoternary Live

SITE ID
Bit Errors
Error Analysis Seconds
Time/Date
Violations
Average Violation Rate
Violation Rate
Violation-Free Error Analysis Seconds
Frame Errors
Average Frame Error Rate
Frame Error Rate
CRC Errors
Average CRC Error Rate
CRC Error Rate
Frame Word Errors
Average Frame Word Error Rate
Frame Word Error Rate
RCV FREQ
GEN FREQ
Interface

Pseudoternary Standard (continued)

CRC Error Rate
FAS Errors
Average FAS Error Rate
FAS Error Rate
RCV FREQ
GEN FREQ
Interface

ISDN

Layer 2 Frame Errors
Frame Check Sequence Errors
Layer 2 Frame Abort
Number of L2 Frames
Rejection Frames
Frame Rejection Frames
Power Feeding Status
Receiver Signal Level Measurement (Volts)
Receiver Signal Level Measurement (dB)
Transmitter "INFO" Sequence State
Receiver "INFO'" Sequence State
TEI Assignment
Violated Frame Seconds

Table 4-6
Pattern Summary

Pattern:	Timing Modes:	LUP Required in Sync/Recovd Modes?	Sync Acquisition Threshold:
USER1	Sync/Async Recovd	YES	Synchronous timing: See AUX 45 Asynchronous timing: 10 characters
USER2	Sync/Async Recovd	YES	Synchronous timing: See AUX 45 Asynchronous timing: 10 characters

Table 4-6
Pattern Summary (continued)

Pattern:	Timing Modes:	LUP Required in Sync/Recovd Modes?	Sync Acquisition Threshold:
USER3	Sync/Async Recovd	YES	Synchronous timing: See AUX 45 Asynchronous timing: 10 characters
1:7	Sync/Recovd	NO	30 bits
3-in-24	Sync/Recovd	NO	30 bits
T1-1	Sync/Recovd	YES	Pattern Length
T1-2	Sync/Recovd	YES	Pattern Length
T1-3	Sync/Recovd	YES	Pattern Length
T1-4	Sync/Recovd	YES	Pattern Length
T1-5	Sync/Recovd	YES	Pattern Length
T1-6	Sync/Recovd	YES	Pattern Length
T1-mW	Sync/Recovd	YES	Pattern Length
DDS-1	Sync/Recovd	YES	Pattern Length
DDS-2	Sync/Recovd	YES	Pattern Length
DDS-3	Sync/Recovd	NO	30 bits
DDS-4	Sync/Recovd	NO	30 bits
DDS-5	Sync/Recovd	YES	Pattern Length
DDS-6	Sync/Recovd	YES	Pattern Length

SECTION 5
FUNCTIONAL DESCRIPTION

5.1 SECTION SUMMARY

This section describes the FIREBERD 6000's error, timing, and signal analysis capabilities, as well as the instrument's many modes of operation. This section also describes analysis results and the methods by which they are accumulated. Timing modes are described at the conclusion of this section.

5.2 ERROR ANALYSIS

As used in this manual, the term error analysis refers to the FIREBERD 6000's ability to test *out-of-service*. In out-of-service testing, all live data is removed from the circuit or equipment under test; in its place, the FIREBERD transmits a known data pattern to another FIREBERD or to itself via loopback; the instrument then recognizes the transmitted data pattern and analyzes it for bit errors, data polarity, data losses and (in certain instances) clock losses, pattern slips, character errors, and framing errors. Most results are available through the ANALYSIS RESULTS display and/or optional printer. Some of the results are correlated with time and position to yield more refined information such as the bit error rate, the block error count, and error-free seconds.

In contrast to timing and signal analysis, most error analysis can only be performed when an incoming data pattern is recognized by the FIREBERD; many error analysis results are not available when the FIREBERD is monitoring live data (see Section 5.2.3.2).

5.2.1 Methods of Operation

5.2.1.1 Full-Duplex

During normal system testing, clock and data outputs from the FIREBERD 6000's generator drive the system under test; clock and data signals from the system under test are supplied to the FIREBERD's receiver inputs. Transmission and reception of data occur continuously and independently. This method of operation is known as *full-duplex*, which is available in all timing modes and bit rates.

Full-duplex operation of the FIREBERD allows data transmission to be temporarily stopped; when transmission resumes, the outgoing data pattern continues at the precise point at which it was halted. This process is made possible by *in-band* or *out-of-band* flow control.

Available only when transmitting asynchronous messages, in-band flow control makes use of user-programmable XON and XOFF characters imbedded in the received data stream. The FIREBERD does not respond to in-band flow control characters unless specifically programmed in Auxiliary Function 09 (see Section 4).

Out-of-band flow control makes use of interface signaling leads to control data transmission and may be used regardless of data type or timing. It is normally disabled so that the FIREBERD will transmit unconditionally; however, Auxiliary Function 08 (see Section 4) makes transmission conditional upon any or all of the following signaling leads being in the ON state: DTR (TR), DSR (DM), RTS (RS), CTS (CS), and RLSD (RR).

Data transmission is also affected by Auxiliary Function 04 (Single Transmit). which allows such transmission to be automatically halted. When enabled, one complete pseudo-random pattern or message is sent each time the RESTART switch is pressed. Pattern lengths for Mark and 1:1 data are 24 bits for synchronous operation and approximately 1000 bits (see Section 5.2.2.5) for asynchronous operation. This auxiliary function is available in all timing modes and bit rates; however, single transmit is not available with synchronous user patterns.

5.2.1.2 Self-Loop

As an alternative to full-duplex operation, the user can select self-loop operation (via the SELF LOOP switch). In self-loop operation, the FIREBERD's transmit data and clock leads are connected to the receive data and clock leads, establishing an internal loop for testing the FIREBERD and its selected interface. Self-loop isolates the clock and data drivers and receivers from the interface connector; as a result, the user can disconnect the FIREBERD without removing cables from the interface. In this mode, both incoming and outgoing signaling lines remain active and connected to the system under test.

Self-loop operation is used to verify proper instrument setup and to check the operation of the installed data interface

at the specified data rate. Data is continuously transmitted and received regardless of out-of-band flow control or the setting of the Single Transmit auxiliary function. Additionally, both in-band and out-of-band flow control are disabled so that data generation is performed unconditionally. Note that self-loop operation does not cause interface signaling leads to be looped. Additionally, all available error analysis results are exactly the same as full-duplex operation.

5.2.2 Data Generation

The FIREBERD 6000's data generator provides fixed patterns, pseudorandom patterns, and messages for use in out-of-service testing. These patterns and messages, as well as a detailed discussion of the FIREBERD's data generation capabilities, are discussed in the following sections.

5.2.2.1 Fixed Patterns

Seven types of fixed patterns are available, as follows:

- Continuous Mark (MARK)
- Alternate Mark and Space (1:1)
- One Mark and Seven Spaces (1:7)
- Three Marks separated by three spaces, followed by 15 consecutive Spaces (3-in-24)
- Six DDS-specific patterns
- Seven T1-specific patterns
- Any 3- to 24-bit, user-programmable pattern (entered using Auxiliary Function 33, described in Section 4)

Fixed data pattern are described in detail in Section 3 (see DATA).

5.2.2.2 Pseudorandom Patterns

Seven different pseudorandom patterns are available, as follows:

- 63 (2^6-1)
- 511 (2^9-1)
- 2047 (2^{11}-1)
- 2^{15}-1
- 2^{20}-1
- 2^{23}-1
- QRSS

Each pseudorandom pattern is a maximal length sequence generated from a feedback shift register of length **n** (where n = 6, 9, 11, 15, 20 or 23). The generated sequence is repeated every 2^n-1 bit periods, with properties that ensure that no more than **n** sequential ones (Marks) or **n - 1** sequential zeros (Spaces) will ever occur.

The Quasi-Random Signal Source (QRSS) pattern is derived from a 2^{20}-1 pseudorandom pattern and is modified to have no more than 14 consecutive zeros. This allows the FIREBERD 6000 to be compatible with test sets used exclusively for Tl testing.

5.2.2.3 Messages

Four different messages are provided by the FIREBERD 6000: a FOX message and three user-programmable messages.

FOX Message

In asynchronous transmission, the FOX message is available in four different code levels. The specific code used by the test instrument in generating the FOX message is determined by the number of data bits as follows:

Number of Data Bits	Code
5	Baudot
6	BCDIC
7	ASCII
8	EBCDIC

When Long User Pattern capability is installed, a 7-bit fox message is also available in synchronous transmission. The FOX message takes this form: THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 1234567890 (CR) (LF).

User-Programmable Messages

User-programmable messages are employed when the DATA switch is set to the USER position. Programmed via Auxiliary Function 41 (see Section 4), these messages are created using the MENU keypad and have a maximum length of 2048 hexidecimal characters. For message entry purposes, each character is represented by two hexadecimal digits. Messages may also be entered in ASCII through a dumb terminal or other remote controller.

When using asynchronous timing and the code level is set to 5, 6, or 7, the 5th, 6th, or 7th **least significant bits** of each character pair are transmitted. The character pair is transmitted in its entirety when an 8-level code is chosen.

5.2.2.4 Data Generation With Synchronous and Recovered Timing

When synchronous or recovered timing is selected, all fixed patterns, pseudorandom patterns, and most messages

are available. Note, however, that synchronous messages are only available when Long User Pattern capability is installed.

When synchronous timing is selected, the maximum data rate is restricted by the currently selected interface. When recovered timing is selected, the maximum data rate must be the lesser value of: (1) the interface selected by the user or (2) 520 kb/s.

Note that the data generator's output can be inverted using Auxiliary Function 06.

5.2.2.5 Data Generation With Asynchronous Timing

When asynchronous timing is selected, the MARK, 1:1, FOX, USER, and all pseudorandom patterns (with the exception of 2^{20}-1, 2^{23}-1 and QRSS patterns) are available for use. Data generation and receive rates are restricted to a maximum of 20 kb/s.

In asynchronous operation, all transmitted data is framed with start and stop bits. Using the CHAR FORMAT function of the MENU switch, the following parameters may be selected to determine each character's format:

Parameter	Selection
Number of Data Bits	5, 6, 7, 8
Number of Stop Bits	1, 1.5, 2
Parity	Odd, Even, None

Each asynchronous character is transmitted in the following order: start bit, data bits, parity (optional), stop bit(s). The start bit is normally a Space, and the stop bits are normally Marks. When pseudorandom or fixed pattern data is sent, the transmitted order of the data bits is exactly the same as for synchronous or recovered timing. With asynchronous messages, the data bits of each character are sent in order of increasing significance, with the least significant bit immediately following the start bit. In instances where a parity bit is sent, it immediately follows the most significant information bit and immediately precedes the stop bit(s).

As previously described, the FOX message and the user-programmable messages are used during asynchronous transmission. When operating in Asynchronous Single Transmit mode (controlled by Auxiliary Function 4), generated pattern lengths are adjusted to facilitate transmission of character-formatted data. (Messages are not affected since they are entered in character format. One full message is always transmitted in Single Transmit mode; no more, no less.) The pattern length for Mark and 1:1 patterns varies with the selected character size as follows:

Data Bits Character	Characters Transmitted	# Bits Transmitted
5	200	1000
6	167	1002
7	143	1001
8	125	1000

Pseudorandom patterns are fully transmitted. Characters are filled with the pattern data consecutively. If there are not enough pattern bits remaining to fill the last character, bits are added from the beginning of the pattern.

With all timing modes, the data generator's output may be inverted using Auxiliary Function 06. When asynchronous timing is selected, start, stop, and parity bits are inverted along with the data bits.

5.2.3 Receiver Functions

The FIREBERD 6000's receiver is responsible for recognizing and synchronizing to incoming data patterns. It provides information such as data polarity and indicates losses of synchronization and data. The receiver also offers two types of test results: standard (out-of-service) results and live results. Each is discussed in Sections 5.2.3.1 and 5.2.3.2, respectively.

NOTE: The receiver accepts all of the data patterns and messages described in Section 5.2.2, with the same timing and speed restrictions as the data generator.

5.2.3.1 Standard (Out-Of-Service) Results Mode

In standard results mode, error analysis begins when the receiver has successfully synchronized to the received data (as indicated by the illuminated SYNC LED). The following sections describe how synchronization is acquired, and how standard test results are affected by a loss of synchronization.

Sync Acquisition

The FIREBERD uses its autopolarity and receiver circuits to acquire synchronization automatically. The autopolarity circuit automatically corrects any data inversion that occurs in the system under test, and the receiver circuits synchronize to and detect any errors that occur in the received data stream. Note that autopolarity is not available with patterns that require Long User Pattern capability (see Table 4-6 in Section 4).

The setting of the DATA switch determines the data pattern that is expected by the receiver. Under normal

operating conditions, the receiver does not momentarily declare synchronization to any pattern other than the current selection, even in a high bit-error-rate environment.

When synchronous or recovered timing is selected, the FIREBERD's receiver declares synchronization to fixed pattern data (e.g., Mark, 1:1, 3-in-24, etc.) when it has received 30 consecutive bits without errors. For pseudorandom patterns, synchronization is declared upon receipt of 30 + n consecutive error-free bits for a pattern length of 2^n-1 (for the QRSS pattern, n=20). For messages using synchronous timing, synchronization is dependent on Auxiliary Function 45 (USR SYN THR, described in Section 4).

Synchronization Loss

The FIREBERD 6000's receiver declares a loss of synchronization upon the occurrence of these events:

1. A high error rate in the received data. In synchronous and recovered timing, synchronization is typically lost when 250 bit errors are counted in less than 1000 bits of data. Auxiliary Function 10 (Sync Loss Threshold) may be used to decrease this threshold to 100 errors in less than 1000 bits or to increase it to 20,000 errors in less than 100,000 bits. In asynchronous operation, synchronization is lost when 30 errored characters are received in 60 or fewer characters of data.

2. Loss of received data. In synchronous and recovered timing, a data loss is declared when data that is clocked into the receiver does not change state for 63 bit periods. (The data loss detector is automatically disabled upon the selection of Mark data, as well as for fixed patterns of all Marks or all Spaces.) In asynchronous timing, a loss of received data is declared when no characters have been received for 10 seconds. When the FIREBERD 6000 loses synchronization as a direct result of a data loss, the DAT LOSS count is incremented. When a printer is connected to the FIREBERD, "DATA LOSS XXX" is printed on the occurrence of each data loss (if the PRINTER switch is ON and DATA LOSS status messages are enabled). "DATA LOSS XXX" immediately precedes the SYNC LOSS printout, where XXX represents the count of data losses since the beginning of the test.

3. Loss of received clock. In synchronous timing, a clock loss is declared during the absence of high-to-low state transitions on the received clock line for a period greater than 50 milliseconds. When the FIREBERD loses synchronization as a direct result of a clock loss, the CLK LOSS count is incremented. When a printer is connected to the FIREBERD, "CLOCK LOSS XXX" is printed on the occurrence of each clock loss (if the PRINTER switch is ON and CLOCK LOSS status messages are enabled). "CLOCK LOSS XXX" immediately precedes the SYNC LOSS printout when a printer is enabled, where XXX represents the count of clock losses since the beginning of the test.

When a synchronization loss occurs, the SYNC LOST indicator is illuminated, and remains so (even if synchronization is restored) until it is manually reset or the test is manually restarted. As such, SYNC LOST serves to signal the loss of receiver synchronization during the test.

When a printer is connected to the FIREBERD, "SYNC LOSS XXX" is printed on the occurrence of each synchronization loss (if the PRINTER switch is ON and SYNC LOSS status messages are enabled), where XXX represents the number of synchronization losses since the start of the test. Note that data losses, clock losses, and sync losses are numbered independently even though data losses and clock losses always cause a loss of synchronization.

Pre-Synchronization Loss Results

The FIREBERD allows the user to recall the set of test results that were in effect immediately preceding the most recent synchronization loss. In standard results mode, this activity is affected by Auxiliary Function 42 (Pre-Sync Loss Results), which causes a complete set of results preceding the most recent sync loss to be presented in the display. Auxiliary Function 42 also initiates an automatic display hold, which permits scrolling through the pre-sync loss results. The current results may be displayed at any time by pressing the DISPLAY HOLD switch. If the PRINTER switch is ON, Auxiliary Function 42 also initiates a titled printout of these results, and includes the time at which they were stored.

Auxiliary Function 42 also allows access to the test results immediately preceding a loss of AC line power. Since a common results buffer is shared between pre-sync-loss and pre-power-loss results, the auxiliary function only gives the user access to the results preceding the most recent sync loss or the most recent power loss, whichever occurred last. Pre-sync-loss results are cleared when a test is manually restarted. Activation of the auxiliary function before a sync loss or power failure occurs causes the message **Pre sync/power loss results not available** to appear in the MENU display.

When a printer is enabled, the FIREBERD can provide a hard copy of the results preceding a sync or power loss. This activity is controlled by the PRINT EVENT portion of the MENU switch, described in Section 4.

Resynchronization

Under normal circumstances, the FIREBERD immediately attempts to resynchronize when synchronization to incoming data is lost. Auxiliary Function 03 (Receiver Action Upon Sync Loss) allows the user to choose what happens to the test results accumulated when a sync loss occurs. The auxiliary function offers three choices: CLEAR, HALT, and CONTINUE.

When CLEAR (the default setting) is selected, a sync loss causes all test results (except Performance results) to be cleared when synchronization is reacquired; the test is automatically restarted.

When HALT is selected, all test results are suspended until sync is reacquired. Note that when the test interval is a specific number of received data bits, sync losses affect the real-time duration in which the bits occur. This is because the accumulation of all analysis results, including the bit count, is suspended during a sync loss. Thus, in effect, the test interval is specified as the number of received data bits on which error analysis was actually performed. Timed test intervals are not affected by sync losses.

When CONTINUE is selected, test results continue to accumulate while the receiver is trying to resynchronize. In this mode, errors are counted at a BER of approximately 0.5. CONTINUE is not valid when asynchronous timing is selected.

5.2.3.2 Live Data Mode

As an alternative to the Standard results mode, certain code-specific information may be obtained from live data. (Live data mode is accessed through the appropriate interface menu). In this mode, the receiver is disabled; as such, only those results that do not require synchronization to the incoming data are provided. All available results begin accumulating when a signal is detected. By monitoring signal characteristics, the FIREBERD can detect bipolar violations (BPVs), and (if applicable) CRC and framing errors.

5.3 TIMING ANALYSIS

5.3.1 Inverted Clock Detector

The inverted clock detector determines if the phase relationship between the receive clock and data is correct. If the clock is inverted with respect to what is specified for the data interface, the CLK INV indicator illuminates. Such detection only takes place when synchronous timing is selected. Auxiliary Function 02 (Receiver Clock Polarity) does not affect the operation of the inverted clock detector.

5.3.2 Clock Activity Detectors

Clock activity detectors operate on both the transmitter and receiver clocks to indicate when transitions are not present. If a transmitter clock is not detected, the GEN CLK switch illuminates; if a receiver clock is not detected, the NO CLK indicator illuminates.

5.3.3 Receiver Pattern Slip Detector

A pattern slip occurs when the received data pattern has moved forward or backward with respect to the accompanying clock signal. To avoid counting bit errors which directly result from a pattern slip, such errors occurring in the 80 bits surrounding the pattern slip are not counted. Note that this type of pattern slip detection is available in synchronous timing with pseudorandom patterns only.

5.3.4 Frequency Synthesizer

The FIREBERD 6000 features a user-programmable frequency synthesizer that allows operation at any data rate from 50.00 Hz to 15.000 MHz. The synthesizer provides the ability to test at non-standard data rates and stress system performance by operating at frequencies that are offset from the nominal. Section 4 describes how the synthesizer is controlled.

5.3.5 Frequency Measurements

Frequency measurements are performed on both the generator and receiver clocks. The measurements are made over a 1-second interval and are accurate within ±5 ppm ±1 count of the reading (±1 ppm ±1 count optional). The displayed frequency is given in Hertz (Hz) with a resolution as shown in Table 5-1. When asynchronous timing is selected, only the generator clock (or baud rate) is measured; a receiver baud rate measurement is not provided.

Table 5-1
Frequency Range and Corresponding Resolution

Frequency Range	Resolution
greater than 99.9999 kHz	1 Hz
10.0000 kHz to 99.9999 kHz	0.1 Hz
1.00000 kHz to 9.99999 kHz	.01 Hz
less than 1.00000 kHz	.001 Hz

5.4 SIGNAL ANALYSIS

Signal analysis includes both delay and jitter measurements. The delay measurement is discussed in this section; the jitter measurement is discussed in Section 9.

Delay measures the time interval between two user-selectable events. These events include rising or falling edges of signaling leads (DSR, CTS, RTS, etc.), the transmitted or received data, pattern sync signals, or user-supplied signals from rear-panel test points.

The start-of-measurement and end-of-measurement signals can be set independently (Aux. Func. 31). See Section 6.4 for a list of the signals and the instructions for using the auxiliary function. The range of measurement is from 0 to 9999.9 milliseconds, with a resolution of 0.1 millisecond.

By looping back the remote end of a test channel and measuring the delay between generator and receiver pattern sync, a round-trip delay measurement can be obtained. One delay measurement is set up (or "armed") by pressing the RESTART switch, at which time the result display is blank; the RESTART switch must be pressed again to re-arm for another measurement.

5.5 ANALYSIS RESULTS

The FIREBERD 6000 offers a range of test results in various categories. *Since many of these results are interface- and mode-specific, not all of them will appear when running a given test.*

5.5.1 Result Categories

ERROR Category

In standard test mode, the received data is analyzed for bit errors, pattern slips, and refined error results immediately upon synchronizing to a known data pattern.

Bit Errors (BIT ERRS) - The number of errored data bits counted since the beginning of the test.

Average Bit Error Rate (AVG BER) - The ratio of the number of bit errors counted to the number of data bits examined since the beginning of the test.

Bit Error Rate (BER) - The ratio of the number of bit errors counted over the last test interval to the number of data bits examined in the last test interval.

Blocks (BLOCKS) - The number of complete blocks received since the beginning of the test. The length of a block is set through Auxiliary Function 30.

Block Errors (BLK ERRS) - The number of complete blocks received since the beginning of the test that contain one or more bit errors.

Average Block Error Rate (AVG BLER) - The ratio of the number of block errors counted to the number of blocks examined since the beginning of the test.

Character Errors (CHAR ERR) - In asynchronous timing, the number of characters received since the beginning of the test that contain one or more data errors.

Pattern Slips (PAT SLIP) - The number of occurrences since the beginning of the test where data bits have been added to or deleted from the received pattern.

PERFORMANCE Category

CCITT Recommendation G.821-compatible performance results provide statistical information about the performance of the equipment or system under test. These results are derived by observing the received bit error counts and received bit counts at 1-second intervals, and classifying these seconds as available, unavailable, severely errored, or error-free. This division of test time is illustrated in Figure 5-1. Other calculations yield the number and percentage of degraded minutes, and percentages of available, severely errored, and error-free seconds.

In live analysis mode, the received BPV count and rate are used to classify each 1-second interval, and signal presence replaces pattern synchronization for performance analysis purposes.

G.821 Errored Seconds (GERR SEC) - The number of available seconds in which at least one bit error occurred.

G.821 Error-Free Seconds (G EFS) - The number of available seconds in which no bit errors occurred.

G.821 % Error-Free Seconds (G %EFS) - The ratio of the number of available seconds in which no errors were detected to the total number of available seconds, expressed as a percentage.

Degraded Minutes (DEG MIN) - The number of blocks of 60 non-severely errored, available seconds in which the average BER was worse than 10^{-6} (see Appendix B). Note that CCITT Recommendation G.821 eases this requirement at 64 kHz; when the average BER over 60 seconds is 64 kHz, and four bit errors are counted, the minute is not considered to be degraded.

% Degraded Minutes (%DEG MIN) - The ratio of the number of degraded minutes to the number of minutes derived from available, non-severely errored seconds, expressed as a percentage.

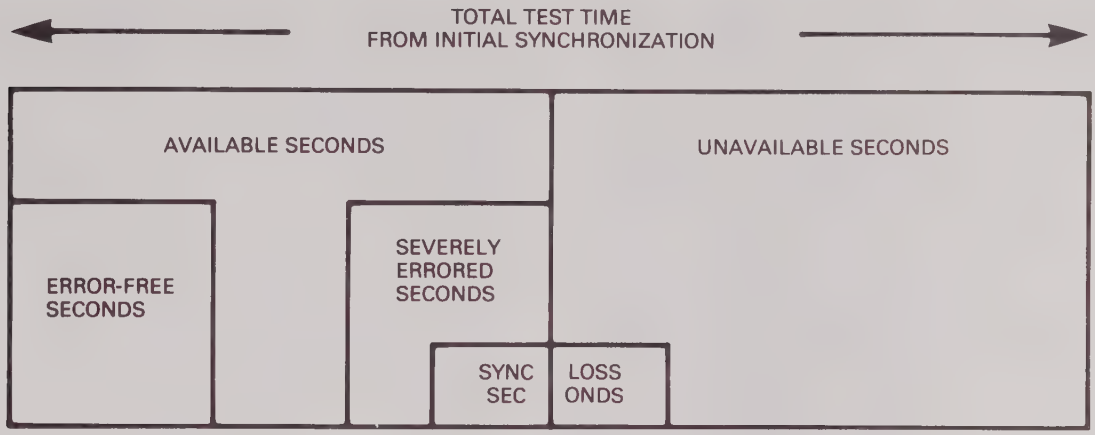


Figure 5-1
Division of Test Seconds for Performance Analysis

Severely Errored Seconds (SES) - The number of available seconds during which the BER is higher than 10^{-3}.

%Severely Errored Seconds (%SES) - The ratio of the number of severely errored seconds to the number of available seconds, expressed as a percentage.

G.821 Violation-Free Seconds (G VFS) - The number of available seconds in which BPVs were not detected.

G.821 %Violation-Free Seconds (G %VFS) - The ratio of the number of available seconds in which BPVs were not detected to the total number of available seconds, expressed as a percentage.

Unavailable Seconds (UNA SEC) - The number of seconds judged unavailable by CCITT criteria (see Appendix B).

Available Seconds (AVL SEC) - The number of seconds judged available by CCITT criteria (see Appendix B).

%Available Seconds (%AVL SEC) - The ratio of the number of available seconds to the number of test seconds since initial pattern synchronization, expressed as a percentage.

Severely Violated Seconds (SVS) - The number of available seconds during which the BPV rate was higher than 10^{-3}.

% Severely Violated Seconds (%SVS) - The ratio of the number of severely violated seconds to the number of available seconds, expressed as a percentage.

Bit Errors Minus Severely Errored Seconds (ERR-SES) - The total number of bit errors, excluding the errors that occurred during severely errored seconds.

Bit Error Rate Minus Severely Errored Seconds (BER-SES) - The bit error rate, excluding the errors that occurred during severely errored seconds.

TIME Category

The TIME category offers a variety of time-based results.

Pattern Sync Loss Seconds (PATL SEC) - The number of seconds during which the receiver was not in continuous pattern synchronization.

%Pattern Sync Seconds (%PAT SEC) - The ratio of the number of seconds in which pattern synchronization was achieved with no synchronization losses to the total number of seconds since initial pattern synchronization, expressed as a percentage.

Signal Loss Seconds (SIGL SEC) - The number of seconds during which the signal was not present for any part of the second.

% Active Seconds (%ACT SEC) - The ratio of the number of seconds during which a signal was present (active) for the entire second to the total number of seconds since initial signal presence, expressed as a percentage.

Time of Day (TIME) - The time of day in hours, minutes, and seconds. Hours are displayed in a 24-hour format. The current time is set using Auxiliary Function 60.

Calendar Date (DATE) - The calendar date in day, month, and year. The current date is set using Auxiliary Function 60.

Elapsed Seconds (ELAP SEC) - The number of seconds, based on the time-of-day clock, since the last major switch change or test restart.

Error Analysis Seconds (EA SEC) - The amount of time during which error analysis has been performed, expressed in seconds. The time that error analysis is performed depends on receiver pattern synchronization and the setting of Auxiliary Function 03 (Receiver Action Upon Sync Loss).

Errored Error Analysis Seconds (ERR EAS) - The number of error analysis seconds during which one or more bit errors were detected. Errored error analysis seconds are asynchronous.

Error-Free Error Analysis Seconds (EF EAS) - The number of error analysis seconds during which no bit errors were detected.

SIGNAL Category

The SIGNAL category offers measurements such as receiver clock frequency or the delay between two events. Optional jitter results are also displayed in this category.

Delay (DELAY) - The most recently measured time interval between the start and finish of specific events. The start and stop events are selected using Auxiliary Function 31.

Maximum Jitter (MAX JTR) - The largest value of 1-second jitter measured since the beginning of the test, expressed in Unit Intervals (UIs) peak-to-peak.

1-Second Jitter (1SEC JTR) - The maximum amount of timing jitter measured over the last 1-second test interval, expressed in UIs peak-to-peak.

Jitter Hits (JTR HITS) - A count of the number of times that jitter has exceeded the selected hits threshold since the beginning of the test.

Positive Wander (+WNDR) - The maximum positive peak wander deviation since the beginning of the test, expressed in UIs.

Negative Wander (-WNDR) - The maximum negative peak wander deviation since the beginning of the test, expressed in UIs.

Peak-To-Peak Wander (PP WNDR) - The total deviation of positive-to-negative peak wander since the beginning of the test, expressed in UIs.

15-Minute Wander (15m WNDR) - The maximum peak-to-peak wander deviation over the last 15 minutes of the test. This result is unavailable during the first 15 minutes of the test and is updated once per minute thereafter.

24-Hour Wander (24h WNDR) - The maximum peak-to-peak wander deviation over the last 24 hours of the test. This result is unavailable during the first 24 hours of the test and is updated once per hour thereafter.

TIE Wander (TIE WNDR) - Time Interval Error (TIE); the variation in time delay of a given signal with respect to the T1 reference signal or external clock source over the test interval.

Receiver Frequency (RCV FREQ) - The current measurement of the receiver clock frequency.

Generator Frequency (GEN FREQ) - The current measurement of the generator clock frequency.

% of Jitter Mask (%MASK) - Each time the jitter spectrum analyzer takes a reading, the ratio of the measured jitter amplitude to the reference jitter mask's value is calculated. If the spectrum analyzer is sweeping, then the maximum value of that ratio since the beginning of the test is displayed as a percentage; a value of less than 100% indicates that no spectrum analyzer reading exceeded the reference mask during the test. If the spectrum analyzer is not sweeping, then the ratio of the last spectrum analyzer reading to the reference mask at that frequency is displayed as a percentage.

Spectrum Analyzer Frequency (S/A nnn) - The current spectrum analyzer frequency in Hertz or, if noted, kHz. Additionally, the measured jitter amplitude at the current frequency is displayed in unit intervals peak-to-peak. If the spectrum analyzer is sweeping, the amplitude is the largest measured at this frequency; if the spectrum analyzer is not sweeping, the amplitude is the last measured at this frequency.

Received Byte (RCV BYTE) - The received data bytes displayed in binary form.

Received Code (RCV CODE) - When a T1 interface is selected, this result reflects the type of line coding received (e.g., B8ZS, AMI, etc.). When a DDS interface is selected, this result reflects the received bytes which are interpreted as special network codes; the name of the network code is displayed in abbreviated form.

ISDN Power Feeding Status (PWR STAT) - In ISDN testing, a check of the NT's power feeding status, displayed as a result.

Receiver Signal Level in Volts (R LVL V) - In ISDN and DDS Local Loop testing, a measurement of the receiver signal level in volts. The range and resolution of this measurement are interface-dependent.

Receiver Signal Level Measurement in Decibels (R LVL dB) - In ISDN and DDS Local Loop testing, a measurement of the receiver signal level in decibels. The range and resolution of this measurement are interface-dependent.

Transmitter Info State (TX INFO) - In ISDN testing, the specific sequence of the line signals used to bring the NT and TE into synchronization.

Receiver Info State (RCV INFO) - In ISDN testing, the specific sequence of line signals used to bring the TE and NT into synchronization.

Terminal Equipment Identifer (TEI) - When testing an AT&T ISDN switch, the actual TEI assigned.

Positive Receive Level in Volts (+LVL V) - The level of the received signal in volts, measured on the positive T1 pulses. The range and resolution of this measurement are interface-dependent.

Positive Receive Level in Decibels (+LVL dB) - The level of the received signal in decibels, relative to the positive level measurement. The range and resolution of this measurement are interface-dependent.

Negative Receive Level in Decibels (-LVL dB) - The level of the received signal in dB, relative to the negative level measurement. The range and resolution of this measurement are interface-dependent.

Negative Receive Level in Volts (-LVL V) - The level of the received signal in volts, measured on negative pulses. The range and resolution of this measurement are interface-dependent.

Receive Level in Decibels (-LVL dBm) - The power level of an unframed all-ones signal (available only when AIS is detected).

Peak-to-Peak Receive Level in Volts (PP LVL V) - The level of the received signal in peak-to-peak volts. The range and resolution of this measurement are interface-dependent.

Data Rate (DAT RATE) - In local loop testing, the received data rate of the primary or secondary channel being analyzed, expressed in b/s.

Simplex Current in mA (SMPX CUR)
The magnitude of the simplex current flowing between the transmit output tip and ring and the receive input tip and ring (interface-dependent).

T-CARRIER Category

This category contains interface-specific analysis results.

Bipolar Violations (BPVs) - In T1 testing, the number of BPVs detected in the received signal.

Average BPV Rate (AVG BPVR) - In T1 testing, the ratio of the number of BPVs detected to the number of data bits examined since the beginning of the test.

BPV Rate (BPV Rate) - In T1 testing, the ratio of the number of BPVs detected over the last test interval to the number of data bits examined.

Code Errors (CODE ERR) - In 2048 kb/s testing, the number of code errors detected in the received signal.

Average Code Error Rate (AVG CER) - In 2048 kb/s testing, the ratio of the number of code errors detected to the number of data bits examined since the beginning of the test.

Code Error Rate (CER) - In 2048 kb/s testing, the ratio of the number of code errors detected over the last test interval to the number of data bits examined.

Violation-Free Error Analysis Seconds (V F EAS) - The number of error analysis seconds during which no BPVs or code errors were detected.

% Violation-Free Error Analysis Seconds (% V F EAS)- The number of violation-free error analysis seconds to the number of error analysis seconds since the beginning of the test.

Frame Errors (FRA ERR) - The number of errored framing bits detected since the beginning of the test.

Average Frame Error Rate (AVG FER) - The ratio of the number of frame errors detected to the number of framing bits examined since the beginning of the test.

Frame Error Rate (F E Rate) - The ratio of the number of frame errors counted over the last test interval to the number of framing bits examined in the last test interval.

Frame Losses (FRA LOSS) - The number of times that frame synchronization has been lost since the beginning of the test.

CRC Errors (CRC ERR) - The number of CRC errors detected since the beginning of the test.

Average CRC Errors (AVG CRC) - The ratio of the number of CRC errors detected to the number of CRCs examined since the beginning of the test.

CRC Error Rate (CRC E Rt) - The ratio of the number of CRC errors detected over the last test interval to the number of CRCs examined.

Frame Alignment Signal (FAS) Errors (FAS ERR) - In 2048 kb/s testing, the number of FAS errors detected since the beginning of the test.

Average FAS Error Rate (AVG FAS) - In 2048 kb/s testing, the ratio of the number of FAS errors detected to the number of frame words examined since the beginning of the test.

FAS Error Rate (FAS E Rate) - In 2048 kb/s testing, the ratio of the number of FAS errors detected over the last test interval to the number of frame words examined in the last test interval.

One-Second CRC Errors (1 SEC CRC) - The number of CRC errors counted in the last test second.

Layer 2 Frame Errors (L2 F ERR) - In ISDN testing, the number of layer 2 frame errors. Caused by receiving an LAPD frame (packet) that does not have an integral number of octets.

Frame Check Sequence Errors (FCS ERR) - In ISDN testing, the number of frames with an incorrect CRC set.

Layer 2 Frame Abort (L2 ABORT) - In ISDN testing, the number of layer 2 frame aborts. Frame aborts terminate the LAPD frame in progress without processing.

Number of Layer 2 Frames (L2 FRMS) - In ISDN testing, the total number of Layer 2 frames received.

Rejection Frames (REJ FRM) - In ISDN testing, the number of rejection frames sent by the peer entity in response to a frame received with an FCS (CRC) error.

Frame Rejection Frames (FRMR) - In ISDN testing, the number of frame rejection frames sent by the peer entity in response to an unrecognized entity (e.g., bad flag, unknown command).

Maximum Zeros (MAX ZERO) - The maximum number of consecutive zeros received since the last test restart.

Bit Slips (BIT SLIP) - In T1 testing, the number of bit slips in a frame, ranging from -32767 to +32767.

Received Bit Oriented Message (RCV BOM) - In T1 testing, one of five ASCII messages on the ESF data link, as follows:

- YEL ALM - yellow alarm
- LLB ACT - line loopback activate
- LLB DEA - line loopback deactivate
- PLB ACT - payload loopback activate
- PLB DEA - payload loopback deactivate

Received BOMs not listed are displayed in binary form.

Received ABCD (RX ABCD) - In T1 testing, the ABCD signal of a DS0 channel selected via the interface set-up menu.

ALARM Category

The FIREBERD 6000 monitors several alarm conditions and counts the number of times each one occurs. Alarms such as signal, pattern sync, data, clock, or power loss indicate conditions that affect the test in progress.

Pattern Synchronization Loss (PAT LOSS) - The number of times a pattern synchronization loss is detected.

Data Loss (DAT LOSS) - The number of times a receiver synchronization loss results from a loss of receiver data.

Clock Loss (CLK LOSS) - The number of times a receiver sync loss results from a loss of receiver clock.

Receiver Clock-Data Phase Changes (C-D CHA) - The number of times that the clock-data phase has changed since the beginning of the test.

Power Loss (PWR LOSS) - The number of power losses since the last manual test restart or major switch change.

Signal Loss (SIG LOSS) - The number of times the receiver signal is lost.

Yellow Alarm Seconds (YEL SEC) - The number of seconds since the beginning of the test in which a yellow alarm was active.

Excess Zero Seconds (XS0 SEC) - The number of seconds since the beginning of the test in which excess zeros have occurred.

Alarm Indication Signal Seconds (AIS SEC) - The number of seconds since the beginning of the test in which the AIS alarm was active.

Ones Density Seconds (1s DEN S) - The number of seconds since the beginning of the test in which ones density violations have occurred.

Violated Frame Seconds (V FR SEC) - A count of the number of seconds in which there was at least one violated frame.

Remote Alarm Seconds (REM SEC) - A count of the number of seconds in which at least one remote alarm has occurred.

5.5.2 Messages

The FIREBERD 6000 alerts the user to several conditions by temporarily placing a message in the display. The following is a list of the messages and their descriptions.

Async frequency contention - the selected frequency is not compatible with asynchronous operation. This message is generated when asynchronous timing is selected and the frequency synthesizer is set to a value greater than 20 kHz. While this message is flashing, a default frequency of 20 kHz is used.

Async pattern contention - the selected test pattern is not compatible with asynchronous operation. While this message is flashing, a default pattern of 1:1 is used.

Frame loss - a frame synchronization loss has occurred.

Different intf - the configuration being recalled includes an external interface which does not match the one that is currently installed.

Gen hold <sig> off - shows which signal is causing a hold condition when the generator is inhibited (<sig> is replaced by the name of the signal). Transmission can be stopped by CTS, RTS, DTR, DSR, or RLSD via Auxiliary Function 08.

Async framing err - framing errors are detected in the incoming asynchronous data.

Data overrun - the USART received too many characters before the FIREBERD received the data from the USART. Occurs during asynchronous testing.

No interface - the FIREBERD is powered up with no modular interface installed.

Dialing - in ISDN testing, displayed when the DIAL softkey is pressed.

Ringing - in ISDN testing, indicates the presence of an incoming call.

Ring Back - in ISDN testing, indicates the call is ringing on the network end.

Call Connected - in ISDN testing, indicates that the call is connected on the network.

Connect Fail: XXX - call failed, where XXX is a value from 1 to 255. This message alternates with the cause of the failure.

Call Cleared - in ISDN testing, indicates the normal termination of a call.

Interface ERR: XX - ISDN interface error detected.

Data Call Ignored - in ISDN testing, indicates that the incoming data call ignored (as specified in the ANSWER menu).

This TE Not Active - in ISDN testing, indicates that the user presses the DIAL softkey while in DEACT state.

B Channel in Use by this TE - in ISDN testing, indicates that the user pressed DIAL while a call on the selected B-channel was in progress.

5.6 TIMING MODES

The FIREBERD 6000 offers four timing selections: synchronous, asynchronous, recovered, and pseudoternary.

Synchronous operation requires both a data and a clock signal. Asynchronous operation only requires a data signal, but several parameters must be coordinated between the transmit and receive units (i.e., baud rate, number of bits, parity, etc.). Recovered operation is similar to synchronous operation except that the received clock (if any) is ignored and a clock is derived from the data. Pseudoternary operation has the clock and data encoded in the same signal; however, the bit rates are restricted to certain frequencies and interfaces.

With the exception of pseudoternary operation, timing is selected by the TIMING MODE switch. When a pseudoternary interface is selected, the TIMING MODE switch is disabled. All timing modes are described in detail in the following sections.

5.6.1 Synchronous Timing and Operation

When synchronous timing is selected, the FIREBERD operates as a standard DTE or DCE, with several features which provide additional flexibility for testing. The data is a stream of bits accompanied by a synchronous clock.

The FIREBERD provides data and a synchronous clock based on the generator clock source selected. The GEN CLK switch allows one of three clock sources to be chosen: the synthesizer (SYNTH), the interface (INTF), or a user-provided clock source (BNC). The INTF setting uses a clock source from the data interface module. When the FIREBERD is emulating a DTE, this interface clock is usually sourced from the remote unit; when emulating a DCE, the receiver clock is used as the clock source.

The FIREBERD's receiver requires data and a clock which is synchronized to that data. When the clock is not synchronized to the data, clock slips and/or clock-data phase changes may occur. The FIREBERD automatically selects a receiver clock appropriate for the timing mode and the interface selected. When emulating a DCE, the TT (Transmit Timing)

signal is normally used; if TT is not active, ST (Send Timing) is automatically selected. Auxiliary Function 07 can be used to override this feature.

5.6.2 Recovered Timing

Depending on the option used, the FIREBERD 6000 can operate in two different recovered timing modes. A Clock Recovery option is offered as an internal mainframe for isochronous data rates to 520 kb/s.

Each pseudoternary interface includes a custom clock recovery circuit to extract the clock from the pseudoternary signal.

5.6.2.1 Recovered Operation With DTE/DCE Data Interfaces

When the frequency is less than 520 b/s, any data interface that can use synchronous timing (including the built-in RS-232 data interface) can also be used with recovered timing. When the Clock Recovery option is installed, synchronous data may be analyzed (even if the received clock is missing or unusable) by extracting a clock from the receiver data. To use this feature, the synthesizer frequency must be set to the expected receiver frequency. In normal operation, no problems are encountered when the transmit and receive frequencies are identical. When in receive-only operation, the synthesizer must still be set to the expected receive frequency. To run the FIREBERD in split frequency and also use the option, the synthesizer must be set to the receive frequency and the GEN CLK switch must be set to either the INTF or BNC positions with an external source connected to the GEN CLK IN rear panel BNC connector. The receiver frequency and the synthesizer frequency setting may differ by over 1 percent with acceptable operation; however, the best noise immunity is obtained when such differences are minimized. This is accomplished by setting the synthesizer to the expected receiver frequency, reading the actual receiver frequency (RCV FREQ) (available in the SIGNAL results category), and setting the synthesizer accordingly.

5.6.2.2 Recovered Operation With Pseudoternary Data Interfaces

Pseudoternary signals have the clock imbedded in the data; as such, pseudoternary interfaces must recover the clock from the signal. Since clock recovery is automatic, the TIMING MODE switch is disabled. The INTF position of the GEN CLK switch selects either an oscillator on the interface or a clock recovered from the received data, depending on the interface used and its switch settings. The BNC position of the GEN CLK switch allows an external time base to be used so that generator timing is synchronous with a system clock source.

5.6.3 Asynchronous Timing and Operation

Asynchronous timing allows generation and error analysis of character data. Using the frequency synthesizer, any baud rate from 50 b/s to 20 kb/s may be selected. Split frequency operation is also allowed when a customer-provided external reference is used.

To generate asynchronous data, the GEN CLK switch must be set to either the SYNTH or the BNC position. When set to the SYNTH position, the baud rate of the data must be entered as the synthesizer frequency. When set to the BNC position, a clock at 16 times the desired generator baud rate must be provided at the GEN CLK IN BNC input. In all cases where receiver operation is necessary, the synthesizer must be set to the expected receive baud rate. This means that split frequency operation is only allowed when the generator is operated with an external 16-times clock source through the GEN CLK IN BNC input.

SECTION 6
OPERATION INSTRUCTIONS

6.1 SECTION SUMMARY

This section describes the test capabilities of the FIREBERD 6000. Familiarity with the material in Section 5 will aid in understanding these capabilities and interpreting test results. First-time users of the instrument should refer to Section 2 before executing any of the instructions in this section.

6.2 PERFORMING ERROR ANALYSIS

To perform error analysis with the FIREBERD 6000, do the following:

1. Select a test configuration — loopback or end-to-end testing.

   If loopback testing is desired, one FIREBERD is required. If end-to-end testing is desired, two test instruments are required; thus, the remaining procedures should be followed for both instruments.

2. With AC power to the FIREBERD OFF, install the appropriate data interface in the rear-panel slot. Gently press the interface until its aluminum panel makes contact with the FIREBERD's rear panel.

   To prevent the interface from being pulled out, tighten the two fasteners at either end. If the built-in RS-232 data interface is used, no interface need be installed in the rear-panel slot.

3. Connect the FIREBERD to an AC power source. Apply power using the POWER switch.

4. If using an interface that can emulate Data Terminal Equipment (DTE) or Data Communications Equipment (DCE), determine which is required.

   For example, to emulate a DTE using the built-in RS-232 data interface:

   a. Connect the system under test to the connector marked TO DCE on the FIREBERD's rear panel using a standard cable.

   b. Set the MENU switch to the INTF SETUP position.

   c. Press the INT232 to select the built-in RS-232 interface.

   d. Press the DTE softkey to select DTE emulation.

   To emulate a DCE, do the following:

   a. Connect the system under test to the connector marked TO DTE on the FIREBERD's rear panel; a DTE/DCE adaptor cable is not required.

   b. Set the MENU switch to the INTF SETUP position.

   c. Press the INT232 to select the built-in RS-232 interface.

   d. Press the DCE softkey to select DCE emulation.

   After selecting an emulation mode, verify that EMULATE DTE or EMULATE DCE label is displayed under the SYNC LOST LED.

5. Finish setting up the interface using the appropriate MENU softkeys. For interfaces offering standard or live results, select standard.

   NOTE: See the appropriate manual for information on set-up procedures that are specific to your interface.

6. If an external printer or remote controller is desired, connect it to the appropriate printer/remote control interface on the rear panel.

7. Set the TIMING MODE switch to the desired position.

8. If ASYNC timing is selected in Step 7, set the MENU switch to the CHAR FORMAT position. Use the softkeys to choose the number of data bits per character, parity, and the number of stop bits per character.

9. Use the GEN CLK switch to select a clock source.

10. If ASYNC or RECOVD timing is specified in Step 7, or if SYNTH is specified in Step 9, set the MENU switch to the SYNTH FREQ position to select a synthesizer frequency. For asynchronous or recovered timing operation, the frequency must be set to within 1% percent of the bit rate of the incoming data. Note that the synthesizer frequency should be set to the bit rate of the data to be generated.

11. Use the MENU keypad to type the desired frequency and press the ENTER key. Alternatively, the MENU softkeys may be used to select one of the 11 preprogrammed frequencies. Frequency restrictions for asynchronous and recovered timing are given in Section 5.6.

12. Set the DATA switch to the desired pattern. For end-to-end testing, both test sets must have their DATA switches in the same position. Section 3 provides information on the data patterns that can be generated and received by the FIREBERD.

13. If the 10^{-3} indicator is illuminated, press the switch once to turn off error insertion.

14. If not illuminated, press the SELF LOOP switch to verify the FIREBERD's setup prior to actual system testing.

15. If blocks and block errors are to be measured, use Auxiliary Function 30 to set the desired block length.

16. Set any other auxiliary functions desired. If the AUX FUNC IN USE indicator (next to the MENU switch) is illuminated, one or more of the status-select auxiliary functions are set to values other than the default. A list of these functions may be obtained by pressing the IN USE softkey at the top level of the AUXILIARY menu. If desired, Auxiliary Function 99 can be used to return all status-select functions to their default states.

17. If results prints are desired, set the MENU switch to the PRINT EVENT position; use the softkeys to select a print mode and (if NORMAL mode is specified) the events that will generate a printout.

    Set the OFF/ON switch in the PRINTER block to the ON position; the switch should illuminate.

18. Set the MENU switch to the TEST INTERVAL position.

19. Set the test interval to the desired number of received bits or the desired time duration.

20. Set the ANALYSIS MODE switch to CONTINUOUS or SINGLE, as appropriate for your test.

21. If the DISPLAY HOLD switch is illuminated, press it once to turn it off.

22. If the selected data interface allows control of outgoing signaling leads, set them to the desired states. (Signaling lead switches are located above the POWER switch. Switch illumination indicates that the signal identified by the label is in the ON state.)

    RESULT: The SYNC LED should be illuminated, which indicates that the receiver has synchronized to the generated data.

23. Set the left CATEGORY switch to the ERROR position, then use the left RESULT switch to bring BIT ERRS into the display. Ensure that no bit errors have been counted (BIT ERRS = 0).

24. Press (but do not hold) the ERROR INSERT switch, then verify that a single bit error is tallied in the display. Also verify that the red SYNC LOST indicator is not illuminated.

    RESULT: The FIREBERD has successfully achieved SELF LOOP operation, and is ready to perform testing in standard mode.

25. Press the SELF LOOP switch to exit self-loop operation and enter standard mode.

    RESULT: If all connections are successfully established, the SYNC indicator illuminates and error analysis results are available for display and printout.

6.2.1 If Problems Arise

If the error analysis test fails to start (i.e., the SYNC indicators fail to illuminate), do the following:

- Check the RECEIVER LEDs to verify data activity at the receiver's input.

- If performing a synchronous test, set the right CATEGORY switch to the SIGNAL position, then use the right RESULT switch to select the RCV FREQ result; verify that the frequency of the received clock is the same as the received data rate.

- If emulating a DCE, check that Auxiliary Function 07 (Receiver Clock Select) is set properly; if the FIREBERD is using the wrong timing signal to clock in the received data, it will prevent receiver synchronization.

Use the two ANALYSIS RESULTS switches to view test results in all categories. Section 5.5 provides a list of the results available.

6.3 PERFORMING TIMING ANALYSIS

Timing analysis refers to the measurement of certain clock signal characteristics used by a synchronous, digital communication system. These measurements provide information that help isolate the cause of clock-related system errors.

Timing analysis results fall into two broad categories:

- Results that do not require receiver synchronization.
- Results that do require receiver synchronization.

6.3.1 Setting Up a Timing Analysis Test

To obtain timing analysis results that require receiver synchronization, perform the set-up procedure described in Section 6.2 in its entirety.

Timing analysis results not requiring receiver synchronization may be obtained on clock and data sourced by a FIREBERD 6000 or on live signals. To perform timing analysis on live signals, follow the procedure in Section 6.2 in its entirety, with the following exceptions:

- Those steps that set up the data generator (e .g., setting the GEN CLK switch, entering the synthesizer frequency, etc.) may be skipped.

- The SYNC indicator need not illuminate when the SELF LOOP switch is turned off.

6.3.2 Timing Analysis Results Not Requiring Receiver Synchronization

6.3.2.1 Detecting Clock Activity

Clock detection is the most basic timing analysis result provided by the FIREBERD.

When incoming clock activity is not detected, the NO CLK indicator is illuminated. In DCE emulation, this indicator is affected when Auxiliary Function 07 (Receiver Clock Select) is set to AUTO mode. In this mode, the FIREBERD selects the clock sourced by the DTE on the Terminal Timing (TT) line *if it is present*; when not present, the instrument selects its own generator clock (Send Timing, or ST). As such, the NO CLK indicator illuminates when no signal is present on the incoming TT line *and* no activity is detected at the generator clock.

SUGGESTION: If a clock is expected from the DTE, set Auxiliary Function 07 to TT; this forces the FIREBERD to select the TT signal whether it is present or not. When not present, the NO CLK indicator illuminates.

Note also that the GEN CLK switch illuminates when no clock activity is detected at the selected source. When the GEN CLK switch is set to the INTF position, this indicator provides information about timing signals at the interface. In DTE emulation mode, Send Timing is chosen in this position; in DCE emulation, Terminal Timing is chosen.

6.3.2.2 Improper Phase Relationships

A more sophisticated form of timing analysis is the detection of an improper phase relationship between the incoming clock and data. If the sampling edge of the clock (as defined by the applicable interface standard) is, on the average, closer to the data transitions than to the mid-bit position, an inverted clock condition is declared and the CLK INV indicator is illuminated.

If the frequency of the receiver clock is slightly different than that of the incoming data (i.e., less than about 2 Hz), the CLK INV indicator flashes the frequency difference as the clock slowly slips by the data.

SUGGESTION: Check the C-D CHA result (in the ALARMS category) to count the number of times the CLK INV indicator has changed status since the beginning of the test. This result helps in diagnosing problems that can arise from slowly slipping clocks by "watching" the CLK INV indicator during long-term tests.

6.3.2.3 Generator/Receiver Clock Frequencies

Generator and receiver clock frequency measurements diagnose problems resulting from the wrong frequency or improperly selected timing signals. These measurements can also reveal the presence of electrical noise on clock signals. When of sufficient magnitude to impair system operation, such noise generally appear as clock frequency measurements that are somewhat higher than the actual clock rate.

Available in the SIGNAL category of the ANALYSIS RESULTS switch, generator and receiver frequency measurements have 6 digits of resolution and ±5 ppm ±1 count (±1 ppm ±1 count optional) accuracy, regardless of frequency. The FIREBERD measures both simultaneously.

6.3.3 Timing Analysis Results Requiring Receiver Synchronization

6.3.3.1 Pattern Slips

The timing measurement that requires receiver synchronization is *pattern slips*. In a binary, synchronous communication system, one clock edge is expected for each data bit received. If this one-to-one correspondence is lost, even momentarily, a pattern slip occurs. Possible causes of pattern slips include noise on the clock signal, missing or extra clock pulses, and small frequency differences between the data and accompanying clock. Although more rare, a missing data bit(s) (i.e., data slip) also has the effect of disrupting the one-to-one correspondence between clock edges and data bits, and are thus counted as pattern slips.

The FIREBERD 6000 measures pattern slips on pseudorandom data patterns in the Synchronous and Recovered timing modes, and with T1 interfaces, which recover a clock from the incoming data pulses. In recovered clock operation, pattern slips are generally representative of data slips but may also represent the inability of the clock recovery circuit to track the data due to excessive jitter or noise on the received signal.

6.3.3.2 Frequency Deviation Stress Testing

If the data being analyzed passes through a repeater that recovers clock in order to regenerate the signal, pattern slips may result from failure of the repeater's clock recovery circuit to track the incoming data. The FIREBERD 6000's frequency synthesizer may be used to help diagnose this problem through a technique known as *frequency deviation stress testing*, performed as follows:

1. Set the GEN FREQ switch to the INTF position.
2. Set the MENU switch to the SYNTH FREQ position.
3. Offset the frequency slightly from the one expected by the system under test.
4. Set the ANALYSIS RESULTS switch to the ERROR category.

   RESULT: If the pattern slip count or the BER has increased, the system clock recovery is probably faulty. Note that longer pseudorandom patterns increase the stress on clock recovery systems because they contain longer sequences of zeros.

6.4 DELAY MEASUREMENTS

The FIREBERD 6000 measures the delay between the start and finish of these start-of-measurement and end-of-measurement signals.

Start-of-Measurement Signal Sources:

- DTR
- DSR
- RTS
- CTS (emulate DCE only)
- RLSD
- Generator data (GDATA)
- Generator pattern sync pulse* (GPATT)
- DELAY START rear-panel test point

End-of-Measurement Signal Sources:

- DTR
- DSR
- RTS
- CTS (emulate DTE only)
- RLSD
- Receiver data (RDATA)
- Receiver pattern sync pulse* (RPATT)
- DELAY STOP rear-panel test point

To measure delay, use Auxiliary Function 31 to select the precise delay interval to be measured. Pressing the START softkey gives access to the list of start measurement signal sources. Once the start-of-measurement signal has been selected using the appropriate softkey, the signal edge selection may be made. The character / represents the rising edge of the indicated signal, which is defined as the OFF-to-ON transition of signaling leads, the Space-to-Mark transition of data signals, and the logic-low-to-logic-high transition of the rear-panel test point inputs. The character represents the falling edge of the indicated signal. After making the edge selection for start-of-the-measurement signal, press the key twice to return to the top level of the menu. Press the STOP softkey and select the end-of-measurement signal and signal edge to complete the delay measurement setup.

*Not available in Asynchronous timing mode or for synchronous user messages. Also, no edge selection is available for these signals.

The DELAY result is displayed in the SIGNAL category; note that the ANALYSIS RESULTS switch is blanked until the measurement is completed. The measurement is performed with a resolution of 0.1 milliseconds over a range of 0.0 to 9999.9 milliseconds. If the end-of-measurement event is not detected within 99999 milliseconds of the start-of-measurement event, the message **>9999.9 ms.** is displayed.

After a delay measurement is completed, the measurement may be restarted by pressing the RESTART switch, changing or reselecting the start-of-measurement or end-of-measurement event, or changing any major switch on the FIREBERD's front panel. The DELAY result is blanked whenever the delay measurement circuitry is enabled.

With synchronous and recovered timing and with T1 interfaces, the FIREBERD can measure delay between the generator and the receiver pattern synch pulse. Since these pulses occur at the same place in each pattern, the time delay between these two entities in loopback testing is equal to the round-trip data delay.

To ensure prompt and accurate results, care must be taken in choosing a pseudorandom pattern when making round-trip delay measurements. Specifically, the pattern must be of sufficient length to ensure that transmission of one complete pattern at the operating data rate takes a greater period of time than the longest possible delay to be measured. On the other hand, if the pattern is too long, many seconds will elapse between pattern sync pulses; this means that the user will wait a long time before obtaining a result.

These constraints imply that the best pattern to use is the shortest pattern longer than the minimum usable pattern length, given by the following:

minimum usable pattern length =
(data rate) x (maximum delay to be measured)

where data rate is in bits per second, maximum delay to be measured is in seconds, and the minimum usable pattern length is given in bits. If the maximum delay to be measured is unknown, it is probably safe to use 0.7 seconds, which significantly exceeds the round-trip delay through a satellite in geosynchronous orbit of approximately 0.6 seconds.

For example, to make a round-trip delay measurement at 1.544 Mb/s in an environment in which the delay is completely unknown, the minimum usable pattern length would be 1,544,000 b/s x 0.7s = 1,080,800 bits. The shortest pattern provided by the FIREBERD 6000 that exceeds this length is the 2^{23}-1 pattern which has a length of 8,388,607 bits. Using this pattern gives a result in less than 6 seconds.

6.4.1 Notes on Delay Measurements

When making delay measurements, please note these important items:

1. The receiver must be steadily synchronized to the incoming data. When the receiver is out of sync, it does not supply receiver pattern sync pulses to the delay measurement circuitry, making the round-trip delay measurement impossible. For this reason, the delay measurement is prevented from being initiated until the receiver is in sync.

   NOTE: This restriction does not apply to delay measurements between other events.

2. Round-trip delay measurements should only be made using the 63, 511, 2047, 2^{15}-1, 2^{20}-1 or 2^{23}-1 pseudorandom patterns. Measurements made using fixed patterns will provide erroneous results, and measurements made using the QRSS pattern will yield results that are 20.5 bit periods longer than the actual delay.

3. Round-trip delay measurements made with pseudorandom patterns are always one-half bit period longer than the actual delay. Under most circumstances, the difference is not noticed because one-half bit period is only 0.1 milliseconds (the resolution of the measurement) at a data rate of 5 kb/s, and even less at higher rates. But if precise measurements are required, one-half bit period should be subtracted from the measured round-trip delay at lower data rates.

6.5 CONTENTION CONDITIONS

A contention occurs when two or more interface operating parameters are incompatible with certain mainframe operating parameters. The three possible contentions are as follows:

- Asynchronous frequency contentions
- Asynchronous pattern contentions
- Synchronous pattern contentions

6.5.1 Asynchronous Frequency Contention

An asynchronous frequency contention occurs when:

- The GEN CLK switch is set to the ASYNC position *and*
- The internal frequency synthesizer has been set to a value greater than 20 kHz.

When both conditions are detected, the message **ASYNC FREQ CONTENTION** appears in the display.

To remove the asynchronous frequency condition, do either of the following:

1. Select a different internal frequency
2. Select synchronous timing

NOTE: During an asynchronous frequency contention, the internal clock generator defaults to 20 kHz.

6.5.2 Asynchronous Pattern Contention

An asynchronous pattern contention occurs when:

- The GEN CLK switch is set to the ASYNC position *and*
- The selected data pattern is not one of the following: MARK, 1:1, 63, 511, 2047, 215-1, FOX, or USER 1-3.

When both conditions are detected, the message **ASYNC PATTERN CONTENTION** appears in the display.

To remove the asynchronous pattern condition, do either of the following:

1. Select a different pattern
2. Select synchronous timing

NOTE: During an asynchronous pattern contention, the pattern generator defaults to 1:1.

6.5.3 Synchronous Pattern Contention

A synchronous pattern contention occurs when:

- The GEN CLK switch is set to the SYNC position *and*
- The PATTERN switch is set to either the FOX or USER position *and*
- Long User Pattern capability is not installed.

When both conditions are detected, the message **SYNC PATTERN CONTENTION** appears in the display.

To remove the synchronous pattern condition, do either of the following:

1. Select a different pattern
2. Select asynchronous timing

NOTE: During an synchronous pattern contention, the pattern generator defaults to 1:1. Additionally, this condition does not apply when the FIREBERD 6000 is equipped with Long User Pattern capability.

SECTION 7
PRINTER INTERFACES

7.1 SECTION SUMMARY

This section fully describes the FIREBERD 6000's printer interfaces.

7.2 INTRODUCTION

The FIREBERD 6000 is capable of communicating with printers through its built-in RS-232 Printer/Controller Interface or the optional IEEE-488 Printer/Controller Interface. These printer/controller interfaces enable the user to obtain hard-copy printouts of all results and configurations.

The FIREBERD printer/controller interfaces are designed to communicate equally well with either a user operating a dumb terminal or a computer running an applications program. When communicating with a user operating a dumb terminal, the FIREBERD runs interactively; that is, it sends a prompt character to the terminal whenever it is ready to receive a command, and it echoes all command characters back to the terminal as the user types them. When communicating with a computer running an application program, the FIREBERD disables the prompt and echo functions. This allows the remote computer to concentrate on sending commands and getting results.

The RS-232 Printer/Controller interface is configured as data communications equipment (DCE), which allows it to be connected directly to a printer or to any other piece of data terminal equipment. All communications through the RS-232 port are asynchronous using the ASCII-standard character set, with the exception of graphics codes used to produce output to graphics printers, such as the PR-40A printer. The baud rate and character format can be configured using Auxiliary Function 38.

The optional IEEE-488 Printer/Controller interface, which installs into a slot on the FIREBERD rear panel, complies with the IEEE Standard Digital Interface for Programmable Instrumentation (STD 488 1978). The interface offers both Talk-Only and Addressable modes. When operating in Talk-Only mode, the FIREBERD should he connected directly to a listen-only printer. In Addressable mode, the FIREBERD may be connected with up to 14 other devices, one of which must be a controller. Auxiliary Function 39 shows the current IEEE-488 address in Remote Control mode, or TALK ONLY in Printer mode (see Section 7.1.1). The IEEE-488 Printer/Controller Interface is discussed in more detail in the *FIREBERD 6000 Remote Control Handbook*.

7.2.1 Printer Selection

The FIREBERD 6000 may be connected to an RS-232 external printer or may communicate with a printer via the optional IEEE-488 interface. Auxiliary Function 11 is used to choose RS-232 or, when installed, IEEE-488 for printing.

7.3 PRINTER AND GRAPHICS FORMATS

The FIREBERD printouts can be divided into five broad categories: results prints, controls prints, status prints, histogram prints, and jitter frequency prints. Note that both the histogram and jitter frequency printouts may be either graphed on an Epson-compatible graphics printer or listed to a terminal. Each of these prints are described in the following sections.

7.3.1 Results Print

A results print is a hard copy of the results accumulated by the FIREBERD. Results prints may be initiated by:

- User request, via the RESULTS switch
- The occurrence of a user-selected print event

7.3.1.1 Long and Short Printouts

Using Auxiliary Function 35, the user may select which measurements to include in the results printouts. A long results print includes all available test results; a standard results print only includes an abbreviated list of commonly-used results. If neither of these selections is suitable, a custom results print may be specified in which the user may selectively include (or exclude) any available test result.

7.3.1.2 Delta Printouts

If DELTA is selected through the PRINT EVENT function of the MENU switch, automatic Delta printouts occur at the end of each test interval. These printouts only contain data accumulated over the last test interval. The Delta printout

does not include average error rates, performance analysis results, or other long-term cumulative analysis results. In all other respects, the Delta printout is the same as any NORMAL printout (e.g., format, results selections, etc.).

Figures 7-1 through 7-4 show sample results printouts.

```
MANUAL PRINT
18:22:4722 JAN 91     SITE ID     Alpha
BIT ERRS         0    AVG BER    0.E-07
BER         0.E-05    EA SEC         11
EF EAS           11  BPVs             0
AVG BPVR   0.E-07    BPV Rate   0.E-05
RCV FREQ 1544000     GEN FREQ 1544000
RCV CODE       AMI   G %EFS    100.00%
IF  DS1/T1 40540
```

Figure 7-1
Standard Results Print

```
MANUAL      PRINT
18:29:0822 JAN 91     SITE ID     Alpha
BIT ERRS         0    AVG BER    0.E-07
BER         0.E-05    EA SEC         32
ERR EAS          0    EF EAS         32
BPVs             0    AVG BPVR   0.E-07
BPV Rate   0.#-05     PAT SLIP         0
ELAP SEC        33    DELAY      0.0.ms
RCV FREQ 1544000     GEN FREQ 1544000
RCV COD        AMI   PAT LOSS         0
PWR LOSS         0   SIG LOSS         0
XS0 SEC          0   PATL SEC         0
%PAT SEC 100.00%     AVL SEC         32
%DEG MIN             %SES         0.00%
G %EFS    100.00%    G EFS           32
DEG MIN          0   GERR SEC         0
SES              0   UNA SEC          0
%AVL SEC 100.00%     IF  DS1/T1 40540
FRAME SYNCABSENT     B8ZS        ABSENT
YELLOW ALARM   NO    EXCESS ZEROS   NO
SELF LOOF      ON
```

Figure 7-2
Long Results Print

```
MANUAL      PRINT
18:40:0922 JAN 91     SITE ID     Alpha
BIT ERRS         0
```

Figure 7-3
Custom Results Print

```
DELTA       PRINT
18:41:0522 JAN 91     SITE ID     Alpha
BIT ERRS         0    AVG BER    0.E-07
BER         0.E-06    EA SEC           1
EF EAS           1   BPVs             0
AVG BPVR   0.E-07    BPV Rate   0.E-06
RCV FREQ 1544000     GEN FREQ 1544000
RCV COD        AMI   G %EFS    100.00%
IF  DS1/T1 40540
```

Figure 7-4
Delta Print

7.3.2 Controls Print

A controls print lists the current state of all FIREBERD mainframe controls. When applicable, the state of interface controls are also listed. This provides the user with enough information to duplicate the current configuration of the FIREBERD at another time or site.

Figure 7-5 shows a sample controls printout.

7.3.3 Status Prints

A status print informs the user of important developments in an ongoing test. Like the results in a results print, the various status messages may be individually enabled or disabled using Auxiliary Function 36. Most status printouts include a status message, the current time/date, and the site I.D. These status messages include G.821 transitions, overflow prints, data, clock, signal, and synchronization losses, sync acquisitions, changes in receiver clock polarity, power ups, test restarts, and interface-specific prints. When applicable, these messages also include the count of the number of times they have occurred in the current test.

Figure 7-6 shows several samples of automatically generated status prints. Note that the PRINTER switch must be set to the ON position for status prints to occur.

```
CONTROLS          PRINT
16:18:34    03 JAN 91
SITE:             Alpha
DATA:           2^15-1
ERR INS            OFF
SELF LOOP:          ON
GEN CLOCK:       SYNTH
TIMING MODE:      SYNC
SYN FRQ:        64 KHZ
INTERFACE:
INTERNAL RS-232
RI:                OFF
CTS:               OFF
EMULATE:           DTE
DTR:               OFF
RTS:               OFF
TEST INT:         10^5
PRINT EVENT:       NOR
TEST INT PRNT:     OFF
SYNC LOSS PRNT:    OFF
ERROR PRNT:        OFF
TIME PRNT:         OFF
ANALY MODE:        CON
DISPLAY HOLD:      OFF
BLOCK LENGTH:
             1000 BITS
DELAY: DTR/       DTR/
XON CHARACTER:     11
XOFF CHARACTER     13
AUX FUNC IN USE:NONE
PRINT SPEED:      FAST
PRINT TERM:      CR LF
REMOTE:           NONE
PRINTER:        RS-232
RS-232:
DATA BITS:           8
BAUD:             9600
PARITY:           NONE
IEEE-488:           28
```

Figure 7-5
Controls Print

```
TEST RESTART
16:28:37    29 FEB 92
SITE:             Alpha

SYNC ACQUIRED        1
16:28:38    29 FEB 92
SITE:             Alpha

SYNC LOSS            1
16:28:42    29 FEB 92
SITE:             Alpha

SIGNAL LOSS          1
16:28:43    29 FEB 92
SITE:             Alpha

SYNC ACQUIRED        2
16:28:46    29 FEB 92
SITE:             Alpha

G.821 TRANS      PRINT
16:29:28    29 FEB 92
SITE ID           Alpha
BIT ERRS              0
AVG BER         0.E-06
BER             0.E-05
BLOCKS              1135
BLK ERRS              0
EA SEC               42
EF EAS               40
RCV FREQ        1235726
GEN FREQ        2047987
ERR-SES               0
G %EFS          90.00%
IF            2MB G.703
```

Figure 7-6
Status Prints

7.3.4 Histogram Print

A histogram print offers the user a perspective of how a FIREBERD result is changing with time. For example, a histogram could be used to monitor the accumulated bit errors in each hour over a 60-hour period. From this information, the user can determine whether the bit errors were uniformly distributed over the 60 hours or biased towards one point in time.

Histogram analysis of any integer results are initiated and printed using Auxiliary Function 44. Simultaneous histograms may be created for up to three test results, as follows:

1. Set the MENU switch to the AUXILIARY position
2. Select Auxiliary Function 44
3. Press the HST #1 softkey (HST #2 and HST #3 can be accessed by pressing the MORE key).
4. Press the RESULT softkey
5. Select a test result for histogram analysis. The result may be any of the following:

1SEC CRC	:one-second CRC errors
1S DEN S	:ones density violation seconds
AIS SEC	:alarm indication signal
AVL SEC	:available seconds
BIT ERRS	:bit errors
BLK ERRS	:block errors
BLOCKS	:block errors
BPVS	:bipolar violations
C-D CHA	:clock-data phase changes
CHAR ERR	:asynchronous character errors
CLK LOSS	:clock loss
CODE ERR	:code error
CRC ERR	:cyclic redundancy check error
DAT LOSS	:data loss
DEG MIN	:degraded minutes
EA SEC	:errored analysis seconds
EF EAS	:error-free error analysis seconds
ERR SES	:bit errors minus severely errored seconds
ERR-EAS	:errored error analysis seconds
FAS ERR	:frame aligment signal error
FCS ERR	:frame check sequence errors
FRA ERR	:frame error
FRA LOSS	:frame loss
FRMR	:frame rejection frames
GERR SEC	:G.821 errored second
G EFS	:G.821 error-free seconds
G VFS	:G.821 violation-free seconds
L2 ABORT	:layer 2 frame aborts
L2 FRMS	:number of layer 2 frames
L2 F ERR	:layer 2 frame errors
PAT LOSS	:pattern synchronization loss
PAT SLIP	:pattern slip
PATL SEC	:pattern loss seconds
REJ FRM	:rejection frames
REM SEC	:remote seconds
SES	:severely errored seconds
SIG LOSS	:signal loss
SIGL SEC	:signal loss seconds
SVS	:severely violated seconds
UNA SEC	:unavailable seconds
VF EAS	:violation-free error analysis seconds
V FR SEC	:violated frame seconds
XSO SEC	:excess zero seconds
YEL SEC	:yellow alarm seconds

6. Press the UP ARROW softkey.
7. Press the SCALE softkey.
8. Select a vertical scale using the FWD and RVRS softkey to scroll through the list (10, 20, 100, 200, 500, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1M, 2M, 5M, 10M, 20M, and 50M). AUTO is the recommended setting; AUTO chooses the next scale from the list that is greater than the largest sample.
9. Press the UP ARROW key twice.
10. Press the SETUP softkey.
11. Press the #SMPLS softkey to select the number of histogram samples required. The range is 5-60.
12. Press the PERIOD softkey to select a time period (one minute, 15 minutes, 1 hour, or one day.
13. Press the FORMAT key to select a list (Figure 7-7) or graph (Figure 7-8) format.
14. Press the UP ARROW key.
15. Press the ON/OFF softkey to enable histogram activity.

7.3.5 Jitter Frequency Prints

When the DS1 Jitter Spectral Analysis option is installed, a jitter frequency list result is also available, either by itself or as part of a results print. This printout contains the jitter measurements for each of the 40 frequencies monitored by the spectrum analyzer. These measurements include the maximum unit intervals of jitter measured at each frequency along with the percentage of the selected jitter mask that this reading

corresponds to. Again, like the Maximum Jitter result, when this result is included in a Delta print, it reflects only the measurements made during the test interval.

Jitter printouts may be initiated in either graphics or list format using the front panel JITTER functions of the MENU switch. Note that when generating a graphics print through the RS-232 interface, the character format must be set for eight data bits.

Figures 7-9 and 7-10 are examples of the jitter frequency list and graph.

HISTOGRAM LIST

20:57:00 11/15/89

SAMPLE SIZE 1 DAY

SAMPLE	BIT ERRS
1	0
2	200
3	0
4	93
5	8
8	0
7	0
8	0
9	0
10	0
11	0
12	0
13	0
14	0
15	0
18	0
17	0
18	14
19	1
20	0
21	0
22	0
23	0
24	0
25	0
28	0
27	0
28	0
29	13
30	1
31	11
32	3
33	145

Figure 7-7
Histogram List Print

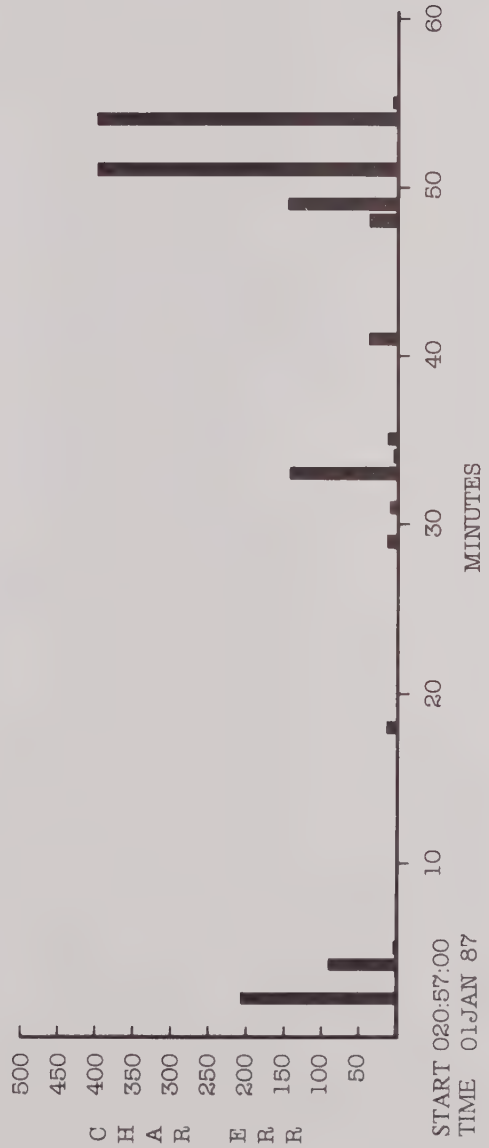


Figure 7-8
Histogram Graph Print

JITTER	FREQ	LIST
15:10:23		01 JAN 87
MASK:		O.171
FREQ (Hz)	UI	% MASK
10	0.04	0.4
20	0.03	0.3
30	0.02	0.2
40	0.05	0.5
50	0.02	0.2
60	0.01	0.1
70	0.01	0.1
80	0.01	0.1
100	0.02	0.2
133	0.02	0.2
166	0.03	0.3
200	0.02	0.2
233	0.03	0.3
300	0.13	1.9
400	1.06	20.9
500	8.15	201.2
600	0.44	13.0
700	0.14	4.8
800	0.10	3.9
1.0k	0.11	5.3
1.3k	0.05	3.2
1.6k	0.04	3.2
2.0k	0.03	2.9
2.3k	0.03	3.3
3.0k	0.03	4.3
4.0k	0.03	5.7
5.0k	0.05	11.9
6.0k	0.03	8.5
7.0k	0.03	10.0
8.0k	0.04	6.6
10k	0.04	13.3
13k	0.04	13.3
16k	0.01	3.3
20k	0.02	6.6
23k	0.01	3.3
26k	0.01	3.3
30k	0.01	3.3
33k	0.02	6.6
36k	0.02	6.6
40k	0.01	3.3

Figure 7-9
Jitter Frequency List

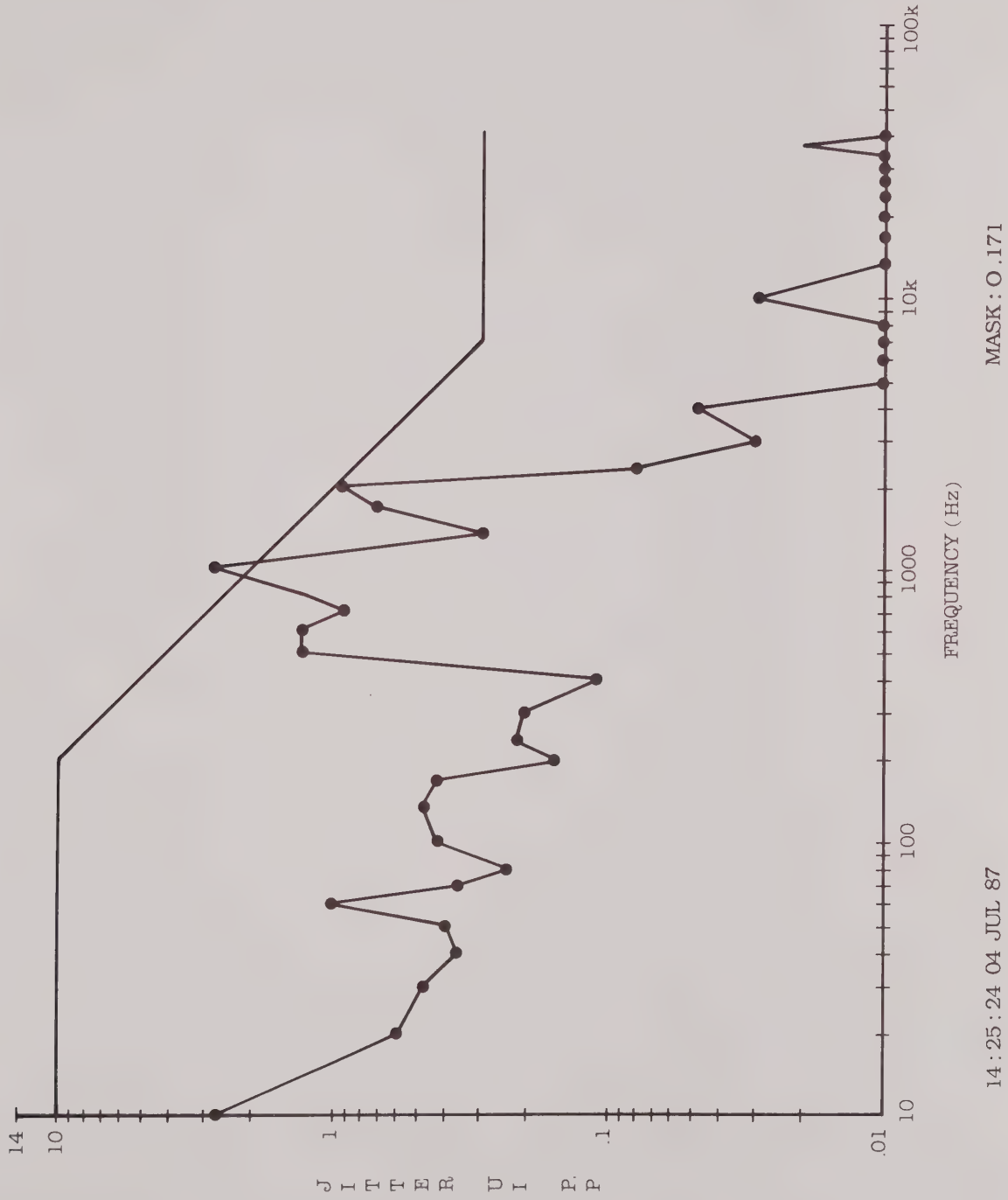


Figure 7-10
Jitter Frequency Graph

SECTION 8
DATA INTERFACES

8.1 SECTION SUMMARY

This section primarily serves to describe the FIREBERD 6000's built-in RS-232 interface, offering functional descriptions, operating instructions, and specifications. Table 8-1 lists additional interfaces that are available for use with the FIREBERD 6000.

Table 8-1
Interfaces Available for the FIREBERD 6000

Model	Description
30608	CCITT G.703 64 kb/s Interface
40380	CCITT G.703 2048 kb/s Interface
30542	CCITT G.703 8448 kb/s Interface
30609	CCITT G.704 2048 kb/s Framing Interface
30481	DS0/DS0A Interface
30678	DS0/DS0A/B Interface
41131	DDS Local Loop Interface
30447A	DS1C/DS2 Interface
40540	DS1/T1/D4/ESF/SLC96 Interface
41440	T1/FT1 Interface
40204	Lab (TTL) Interface
40298	MIL-188-114 Balanced Interface
40226	MIL-188C/MIL-188-114 Unbalanced Interface
40200	RS-449 (422/423) DTE/DCE Interface
41400	RS-449/530/MIL Interface
40202	V.35/306 DTE/DCE Interface
40182	WECO 303 Interface
41075	ISDN S/T TE Interface

Separate operating manuals are available for these data interfaces. If desired, the interface manuals may be inserted in this section.

8.2 THE RS-232-C/V.24 DATA INTERFACE

8.2.1 Introduction

The RS-232-C/V.24 Data Interface, is a built-in feature of the FIREBERD 6000. It meets the EIA RS-232-C Standard, the CCITT V.24 and V.28 Recommendations, and the ISO 2110-1980 Standard.

The RS-232 data interface has two 25-pin D-type female connectors, located on the mainframe rear panel, that enable the FIREBERD to emulate either data terminal equipment (DTE) or data communications equipment (DCE). The DTE connector is labeled TO DCE, and the DCE connector is labeled TO DTE. Table 8-2 lists the pin assignments of the connectors and Figure 8-1 illustrates the 25-pin connector. Both of these connectors share the same FIREBERD drivers and receivers and should not be used at the same time. DTE or DCE emulation is selected from the interface setup (INTF SETUP) menu. Press the MENU pushbutton switch until the LED next to the INTF SETUP label illuminates. Pressing the INT232 softkey selects the internal RS-232 interface. Refer to Figure 8-2 for the RS-232 Data Interface menu.

8.2.2 Functional Description

8.2.2.1 DTE Operation

In a typical RS-232 circuit, the DCE supplies the timing source to the FIREBERD (DTE) on the TC (Transmit Clock) lead (pin 15). When the interface clock is being used as the source of timing, the FIREBERD generates TD (Transmitted Data) (pin 2) and XTC (Transmit Clock) (pin 24) coincident with the clock received on the TC lead.

When the FIREBERD's synthesizer is used as the timing source, the FIREBERD ignores the TC lead and generates TD and XTC coincident with the selected internal rate. The BNC input may also be used to supply generator timing. Data and clock signals received on the RD and RC leads are used for error analysis.

Two pushbutton switches on the FIREBERD front panel allow the RTS (Request to Send) and DTR (Data Terminal Ready) leads to be turned on or off. The status of the Clear to Send (CTS), Data Set Ready (DSR), and Received Line Signal Detector (RLSD) are displayed on the FIREBERD front panel.

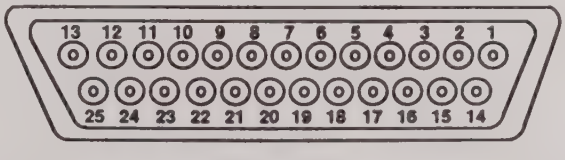


Figure 8-1
25-Pin Connector

Table 8-2
Connector Pin Assignments

Pin No.	Designations EIA	Designations CCITT	Signal Description	Signal Direction TO DCE	Signal Direction TO DTE
1	AA	—	Protective Ground	Connected to chassis ground.	
2	BA	103	Transmitted Data (TD)	Output	Input
3	BB	104	Receive Data (RD)	Input	Output
4	CA	105	Request to Send (RTS)	Output	Input
5	CB	106	Clear to Send (CTS)	Input	Output
6	CC	107	Data Set Ready (DSR)	Input	Output
7	AB	102	Signal Ground	Connected to signal ground.	
8	CF	109	Received Line Signal Detector (RLSD)	Input	Output
15	DB	114	Transmit Clock, DCE source (TC)/ Send Timing (ST)	Input	Output
17	DD	115	Receive Clock, DCE source (RC)	Input	Output
20	CD	108/2	Data Terminal Ready (DTR)	Output	Input
22	CE	125	Ring Indicator (RI)	Output	Input
24	DA	113	Transmit Clock, DTE source (XTC)/Terminal Timing (TT)	Output	Input

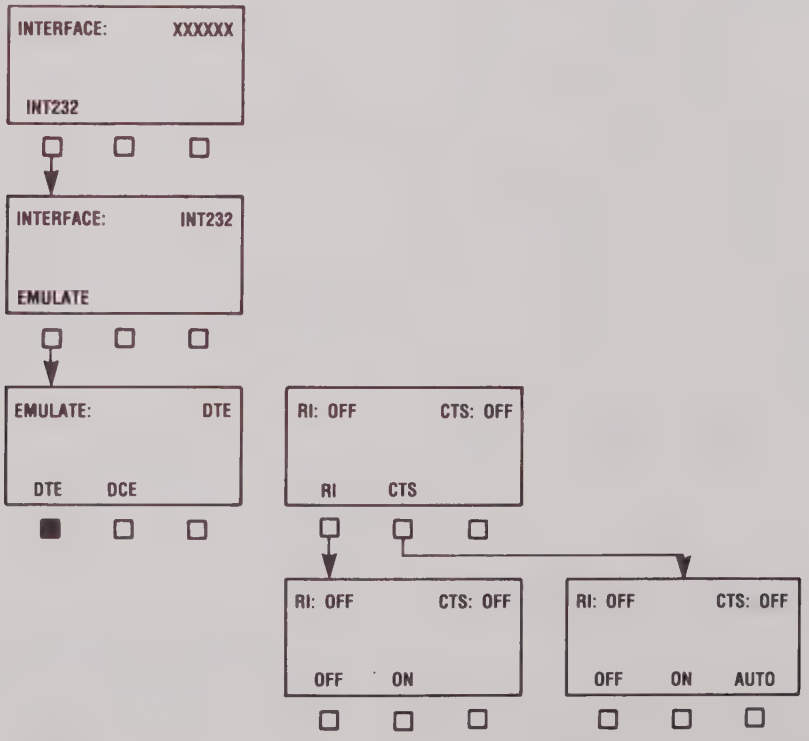


Figure 8-2
RS-232 Data Interface Menu

8.2.2.2 DCE Operation

In a typical RS-232 circuit, the FIREBERD (DCE) supplies timing to the DTE on the TC lead. The DTE returns TD and XTC to the FIREBERD for error analysis.

When the interface clock is being used for generator timing, RD and RC are generated coincident with XTC from the DTE. The FIREBERD may also generate RD and RC coincident with the synthesizer rate or the BNC rate.

Two pushbutton switches on the FIREBERD front panel allow the RLSD and DSR leads to be turned on or off in the DCE mode. DTR and RTS are received and their status is displayed on the FIREBERD front panel. CTS and RI (Ring Indicator) (pin 22) can be turned on or off from the DCE menu. Refer to Figure 8-2 for the RS-232 Data Interface menu.

8.2.2.3 Timing Modes

Three timing modes may be used with this interface: synchronous, asynchronous, or recovered timing. When asynchronous timing is selected, asynchronous data analysis can be performed at data rates up to 20 kb/s. When either synchronous or recovered timing is selected, data analysis can be performed for data rates up to 64 kb/s.

8.2.2.4 Self-Loop

The SELF LOOP switch connects the transmit clock and data outputs to the receive clock and data inputs. User connections do not have to be removed when performing a loop test. In DTE operation, timing for the loop test can be provided on the TC lead (DCE source), by the FIREBERD's synthesizer, or through the BNC connector. The self-loop function tests the actual drivers and receivers that used during normal operation.

8.2.3 Specifications

8.2.3.1 General

Maximum Speed:	64 kb/s.
Data Polarity:	Mark (binary 1): less than -3 volts. Space (binary 0): greater than + 3 volts.
Signal Polarity:	On: greater than + 3 volts. Off: open or less than -3 volts.

8.2.3.2 Drivers

Output rise time:	greater than 20 microseconds.
Generator Impedance:	less than 100 ohms.
Signal Swing:	+10V into 7K ohms typical.
Short Circuit Current:	less than 100 mA.

8.2.3.3 Receivers

Load Impedance:	3K to 7K ohms.
Maximum Input Voltage:	±25V.

8.3 REMOTE CONTROL

The FIREBERD 6000 can be controlled from a remote device using either the RS-232 Printer/Controller Interface or the optional IEEE-488 Printer/Controller Interface (Option 6005). Remote control is possible using either a terminal or a programmed computer attached to the RS-232 Printer/Controller Interface. Remote control may also be accomplished by connecting the FIREBERD's IEEE-488 Printer/Controller Interface to an IEEE bus.

SECTION 9
JITTER OPTIONS

9.1 SECTION SUMMARY

Section 9 offers information on the jitter options available with the FIREBERD 6000. The first half of the section describes DS1 Jitter; the second half describes G.703/G.704 Jitter.

9.2 DS1 JITTER GENERATION AND MEASUREMENT

Jitter on a digital line is the displacement in time of a data pulse from its ideal position. Two parameters are used to characterize jitter. The first is the amplitude of the phase displacement, which varies over time. The amplitude is measured in unit intervals (UI), where one UI is equal to the amount of time associated with one T1 bit period, or 648 nanoseconds at 1544 kb/s. The second parameter is the frequency at which the amplitude is changing measured in Hertz (Hz).

The FIREBERD 6000 offers the following options for testing jitter:

- DS1 Wideband Jitter Measurement (Option 6001)
- DS1 Jitter Spectral Analysis (Option 6002)
- DS1 Jitter Generation (Option 6003)

The DS1 Wideband Jitter Measurement option measures jitter over a wide frequency band (10 Hz to 40 kHz). This measurement follows the guidelines set forth in CCITT Recommendation O.171. The DS1 Jitter Spectral Analysis option performs a 40-band spectrum analysis on the wideband jitter; the DS1 Wideband Jitter Measurement option must be installed to use the Spectral Analysis option. The DS1 Jitter Generator option can apply a sine, square, ramp, triangle, and/or an externally supplied waveform jitter signal to an internal, external, or recovered Tl clock signal.

Each option may be used with the DS1/D4/Fe Data Interface (Model 40460), DS1/T1 Data Interface (Model 40540), or the T1/F1 Data Interface (Model 41440). All three operate simultaneously.

9.2.1 DS1 Wideband Jitter Measurement Option

The DS1 Wideband Jitter Measurement option receives a jittered clock signal from either the DS1/D4/Fe Data Interface, the DS1/T1 Data Interface, or the T1/FT1 Data Interface. The Wideband Jitter option then demodulates the jittered clock and makes the following measurements.

- Peak-to-peak jitter (1SEC JTR)
- Maximum peak-to-peak jitter (MAX JTR)
- Jitter hits count (JTR HITS)

9.2.1.1 Functional Description

The DS1 Wideband Jitter Measurement option demodulates the jittered clock by generating a voltage that is proportional in amplitude to that of the phase displacement. This full bandwidth jitter voltage is sent to two places:

1. The measurement circuits on the Wideband Jitter option
2. The DS1 Jitter Spectral Analysis option for further analysis

After the demodulated jitter signal is sent to the DS1 Jitter Spectral Analysis option, an 8 kHz highpass filter may be selected, if desired. This filter allows only the high frequency components to be measured. The jitter signal, either with or without the filter, is buffered and sent to the BNC connector labeled DEMOD JITTER OUT. The jitter voltage is measured using a peak-to-peak measurement circuit.

The Wideband Jitter option also measures jitter hits. A jitter hit occurs when the jitter exceeds a user-selectable threshold. It is the absolute value of the demodulated jitter that is measured; thus, both positive and negative jitter peaks are compared to the peak jitter threshold.

9.2.1.2 Operation

Figure 9-1 shows the T1 jitter menu tree, accessed by setting the MENU switch to the JITTER position. The DS1

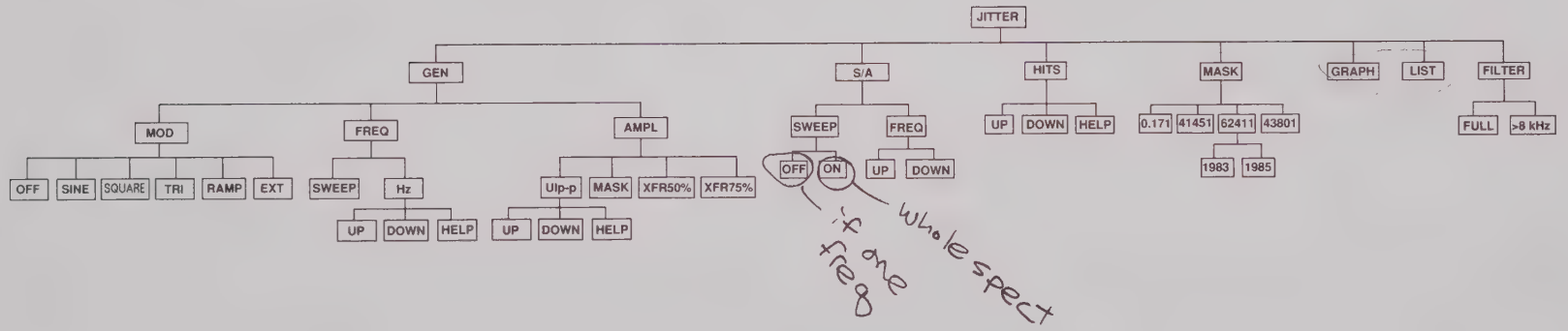


Figure 9-1
Jitter Menu Tree

Wideband Jitter Measurement modes are accessed via two softkeys: HITS and FILTER.

The HITS softkey allows the user to specify a peak jitter threshold within the range 0.1 - 6.5 UIs. The peak jitter threshold may be entered via the keypad by typing two digits and pressing ENTER; the UP and DOWN softkeys can also be used to respectively raise or lower the peak jitter threshold by .1 UI each time one is pressed.

The FILTER softkey controls the highpass filter. When it is pressed, the FULL and >8 kHz selections appear in the display. Pressing the FULL softkey causes the highpass filter to be removed from the jitter measurement path. Pressing the >8 kHz softkey causes the highpass filter to be inserted in the jitter measurement path.

The jitter results - 1 SEC JTR, MAX JTR, and JTR HITS - are found in the SIGNAL category of results. The 1SEC JTR result is the maximum jitter measured over the last second. The MAX JTR result is the maximum of the 1SEC JTR results since the last test restart. If the DS1 Wideband Jitter Measurement option is not installed, these results are not available.

9.2.1.3 Specifications

Data Rate:
- 1544 kb/s.

Bandwidth:
- -20 dB/decade below -3 dB point at 2 Hz.
- -120 dB/decade above -3 dB point at 68 kHz.

Selectable High Pass Filter:
- -20 dB/decade below -3 dB point at 8 kHz.

Measurement Accuracy:
- TERM with 0-20 dB resistive attenuation.
- DSX-MON with 0-30 dB resistive attenuation.
  ±5% ±.04 UI within the range 10 Hz-1 kHz.
  ±7% ±.04 UI within the range 1 kHz-10 kHz.
  ±10% ±.06 UI within the range 10 kHz-40 kHz.
- BRIDGE with 0-24 dB cable attenuation.
  ±7% ±0.3 UI within the range 10 Hz-40 kHz.

Range:
- 0 to 13.00 UI p-p.

Resolution:
- 0.01 UI.

Jitter Hit Threshold:
- Maximum — 6.5 UI.
- Resolution — 0.1 UI.

JITTER OUT BNC:
- Scale — 0.1 V/UI.
- Range — 0-1.3V peak-to-peak.
- Drive Capability — 50 ohms minimum termination.

9.2.2 DS1 Jitter Spectral Analysis Option

The DS1 Jitter Spectral Analysis Option consists of a board that plugs into the Wideband Jitter option. The spectrum analyzer measures the maximum peak-to-peak jitter in 40 frequency bands from 10 Hz to 40 kHz and displays the result in unit intervals UIs peak-to-peak. This option measures:

- Jitter amplitude in UI peak-to-peak with a continuous sweep of 40 frequency bands.
- Continuous jitter amplitude in UI peak-to-peak in 1 of 40 frequency bands.
- Percent of tolerance specification mask for each band.

9.2.2.1 Functional Description

The DS1 Jitter Spectral Analysis option allows the user to determine the spectral content of jitter in a T1 system. This is accomplished by filtering the wideband jitter signal obtained from the DS1 Wideband Jitter option into 40 discrete frequency bands. The output of each filter is then measured using a peak-to-peak measurement circuit. The Spectral Analysis option can either:

1. Continuously measure 1 of the 40 available frequency bands and constantly update the jitter amplitude for that frequency.
2. Continuously sweep through all 40 frequency bands. When the sweep is enabled, each jitter value stored in the 40 frequency bands is compared to the measured value of the corresponding frequency; the maximum value is saved until a test restart occurs.

The sweep function of the Spectral Analysis option operates synchronously with the sweep function of the DS1 Jitter Generation option. The jitter generator generates jitter at a specific frequency, the spectrum analyzer measures that frequency band, and both options increment to the next

frequency band. This capability can be used to test equipment for bit errors or jitter attenuation characteristics. (See the Functional Description in Section 9.3.3.1 for more information.)

The time required to complete one sweep of the spectrum analyzer depends on the jitter generator sweep. When the jitter generator sweep is turned off, it takes approximately 60 seconds to complete one sweep of the spectrum analyzer. When the jitter generator sweep is turned on, it takes approximately 90 seconds to complete one sweep.

Care should be exercised in comparing the spectral analysis results with the wideband jitter result discussed in Section 9.3.1. The Wideband Jitter option makes continuous measurements over the entire 10 Hz to 40 kHz band. The result obtained with that option is a true indication of the maximum jitter over the entire band. This is in contrast to the spectrum analyzer which looks at a much narrower bandwidth for each measurement. In a normal system, jitter measured in the 40 spectrum analyzer bands are added in a complex and nonlinear fashion. As a result, it is important that the wideband measurement be used in conjunction with the spectrum analyzer measurements in determining system performance.

9.2.2.2 Operation

The DS1 Spectral Analysis measurement modes are accessed in the JITTER menu tree (see Figure 9-1) by pressing the S/A softkey. At this level in the menu, the current frequency and the measured amplitude at that frequency are displayed. If the sweep is disabled, the frequency displayed is static, and the amplitude at that frequency is updated as each measurement is completed. If the sweep is enabled, the frequency displayed sweeps along with the measurement, which allows the user to know the status of the sweep at any point in time. In addition, the amplitude displayed for each frequency is the maximum amplitude measured in that band since the last test restart.

Pressing the SWEEP softkey causes the selections ON and OFF to be displayed; selecting either the ON or OFF softkey places the sweep function in the corresponding state. Pressing the FREQ softkey accesses the UP and DOWN softkey results which can be used to scroll through the 40 frequency bands. When the sweep is enabled, the amplitude displayed is the maximum value stored for that band. When the sweep is disabled, either of the UP or DOWN softkeys changes the frequency band currently being measured to the band selected by the softkey.

When the PEAK softkey is pressed, the PEAKUP and PEAKDN softkeys allow the user to quickly find any peaks in the spectrum when the sweep is enabled. A peak is defined as those bands where the jitter is worst in relation to the selected jitter mask. The PEAKUP softkey finds the next higher frequency jitter peak and the PEAKDN softkey finds the next lower frequency jitter peak. Since there are no peaks when the sweep is disabled, the PEAK softkey is not visible if the sweep is off.

The LIST Softkey

When pressed, the LIST softkey sends a list of the jitter spectral analyzer frequency band measurements and their corresponding %MASK values to the selected printer. If the jitter spectrum analyzer sweep is turned off, only one frequency in the list is printed; the others remain blank.

The GRAPH Softkey

When pressed, the GRAPH softkey generates a graph of the DS1 Jitter Spectral Analysis results. The graphics are Epson-compatible and can be used with TTC's PR-85 or PR-40A Printer. The results are graphed only when the jitter spectrum analyzer sweep is on.

9.2.2.3 Spectral Analysis Results

Two spectral analysis results are available in the FIREBERD 6000's SIGNAL category: S/A and %MASK.

The S/A results contain the frequency and the amplitude being measured by the spectrum analyzer. If the sweep is enabled, the frequency sweeps through the 40 bands, displaying the highest amplitude measured in each band. If the sweep is disabled, the frequency is displayed and the amplitude of that frequency is continually updated with each new measurement. The UP softkey increments the frequency; the DOWN softkey decrements the frequency.

The %MASK result compares the measured amplitude of a frequency band to the selected tolerance specification mask value of that frequency. This result indicates whether the jitter amplitude is within the limits specified for a given mask; for example, 110 %MASK is 10% above the allowable jitter level and 50 %MASK is half the allowable jitter level (see Section 9.2.4). If the sweep is disabled, the %MASK corresponds to the frequency being measured. If the sweep is enabled, the %MASK corresponds to the largest %MASK of the 40 frequency bands. The 40 points can all be obtained through the printer or remote control with the jitter list command.

9.2.2.4 Specifications

Data Rate:
- 1544 kb/s.

Frequency Points/ Measurement Bandwidths:
- See Table 9-1.

Filter Bandwidths:
- Specified at the .1 dB and 3 dB points with 36 dB octave roll-off (see Figure 9-2 and Table 9-2).

Accuracy:
- ±10% of reading ±0.05 UI.

Resolution:
- 0.01 UI.

Range:
- 01 to 12.5

Table 9-1
Frequency Point and Measurement Bandwidths

10 Hz BW	33 Hz BW	100 Hz BW	333 Hz BW	1 kHz BW	3.3 kHz BW
10 Hz	100 Hz	300 Hz	1.00 kHz	3.00 kHz	10.0 kHz
20 Hz	133 Hz	400 Hz	1.33 kHz	4.00 kHz	13.3 kHz
30 Hz	166 Hz	500 Hz	1.66 kHz	5.00 kHz	16.6 kHz
40 Hz	200 Hz	600 Hz	2.00 kHz	6.00 kHz	20.0 kHz
50 Hz	233 Hz	700 Hz	2.33 kHz	7.00 kHz	23.3 kHz
60 Hz		800 Hz		8.00 kHz	26.6 kHz
70 Hz					30.0 kHz
80 Hz					33.3 kHz
					36.6 kHz
					40.0 kHz

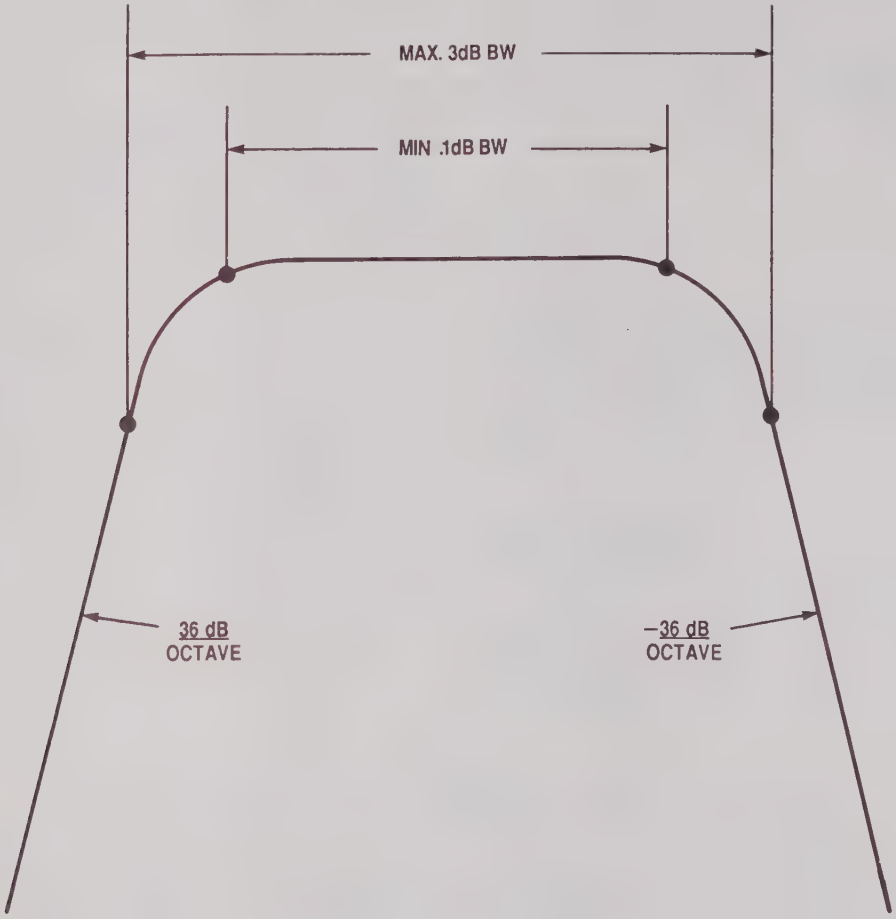


Figure 9-2
Filter Bandwidths

Table 9-2
Filter Bandwidths

Nominal Bandwidth	Minimum .1 kB Bandwidth	Maximum Bandwidth
10 Hz	9.0 Hz	11.9 Hz
33 Hz	30.1 Hz	39.4 Hz
100 Hz	89.5 Hz	117 Hz
333 Hz	301 Hz	391 Hz
1 kHz	904 kHz	1.17 kHz
3.3 kHz	3.02 kHz	3.91 kHz

9.2.3 DS1 Jitter Generation Option

The DS1 Jitter Generation option can phase modulate a T1 signal using an internally generated waveform, an external waveform, or a combination of both to produce T1 jitter. Jitter can be produced on an internal clock, external clock, recovered clock. The following list summarizes the features of the DS1 Jitter Generation option.

Frequency:
- User-selectable frequency, 3-digit resolution
- Can automatically sweep the 10 Hz to 40 kHz band in 40 steps

Amplitude:
- User-selectable amplitude, 0 to 13 UI peak-to-peak, .02 UI resolution
- Can automatically set to selected mask level
- Can automatically set to 50% or 75% of the selected mask level

Modulation:
- Sine
- Square
- Triangle
- Ramp
- External

Clock Sources:
- Internal
- External
- Recovered

9.2.3.1 Functional Description

The DS1 Jitter Generation option can apply jitter to a Tl signal by phase modulating the signal with another waveform. This waveform can be externally generated or internally generated by the jitter generator.

There are three clock sources which can be used with the jitter generator. Each can be selected via the GEN CLK switch.

1. Internal timing. When selected, a 1.544 MHz oscillator on the jitter generator is used. (The frequency synthesizer is used to generate the jitter modulation.)

2. The recovered clock, taken from the DS1/T1 interface's receive input.

3. An external clock source, applied to the BNC connector on the FIREBERD's rear panel.

There are three parameters that are selected with the DS1 Jitter Generation option: modulation type, frequency, and amplitude.

In addition to external modulation, the jitter generator allows four types of internal modulation: sine, square, ramp, or triangle wave. When any one of these waveforms is selected, it is added to the external waveform. If desired, however, the external signal can be the only modulation signal used. If the modulation is turned off, the DS1 Jitter Generation option no longer supplies timing to the DS1/T1 interface.

The modulation frequency can be selected with a 3-digit resolution from 10.0 Hz to 40.0 kHz. As an alternative to fixed-frequency jitter modulation, the FIREBERD can sweep through the same 40 points measured by the spectrum analyzer. In such instances, the instrument generates jitter at each frequency for approximately 1 second. If the spectral analyzer sweep is enabled, the jitter generator and the spectrum analyzer sweep in unison, with jitter generation and spectral measurements occurring simultaneously at each of the 40 points.

Whether or not the jitter generator sweep is enabled, jitter amplitude can be selected manually (UIp-p menu selection) or can be automatically referenced to the selected jitter mask (MASK menu selection). In either case, the range of the jitter amplitude is 0 UI to 13 UI peak-to-peak in .02 UI steps. When MASK is selected, the amplitude of the generated jitter is automatically set to the level specified by the selected mask for the current jitter frequency. MASK is used with the jitter sweep to perform jitter tolerance tests. The jitter generator amplitude can also be set to XFR50% or XFR 75%, which sets the amplitude of the generated jitter to half or three quarters of the jitter specified by the mask, respectively. These selections are used with the jitter sweep to test jitter transfer characteristics.

9.2.3.2 Operation

Jitter generation functions are accessed through the JITTER menu tree (see Figure 9-1). When pressed, the GEN softkey provides entry into the jitter generation menu; at the next level (MOD, FREQ, and AMPL softkeys), the frequency and amplitude displayed reflect the actual amount of jitter being generated. When a contention occurs, these actual amounts may differ from the values which the user has selected. A contention occurs when the amplitude selected is greater than the amplitude that can be generated at the selected frequency;a message is displayed to indicate the contention.

NOTE: At lower levels in the menu, the display always shows the frequency and amplitude values selected by the user, rather than the frequency and amplitude

of the jitter actually being generated. Likewise, when a contention occurs at these lower menu levels, a message is displayed to indicate that a contention exists. To view the actual amount of jitter being generated, the user must return to the top level (GEN softkey) of the menu.

The MOD Softkey

When pressed, the MOD softkey is used to select a modulation-type. If modulation is set to OFF, the generator clock is not modulated; if set to EXT, the external BNC connector (labeled JITTER MOD IN) is the modulation source; the SIN, SQU, TRI, and RAMP softkeys select, sine, square, triangle, or ramp waveforms, respectively. SIN and RAMP are mixed with the BNC to provide the jitter waveform.

The FREQ Softkey

The FREQ softkey is used to selected a frequency. When pressed, two softkey choices are available: SWEEP and Hz.

The SWEEP softkey enables or disables the sweep function. When enabled, SWEEP is displayed instead of the current frequency.

The Hz softkey disables the sweep functions, and allows the desired frequency to be entered. When pressed, three softkey choices are available: UP, DOWN, and HELP.

The UP and DOWN softkeys step through the 40 frequencies corresponding to the spectrum analyzer's 40 bands, and the HELP softkey gives instructions for entering a new frequency from the keypad. The current jitter generator frequency is displayed and a new frequency can be entered and implemented using the MENU keypad and the ENTER key, respectively.

The AMPL Softkey

The AMPL softkey permits amplitude selection. When pressed, four softkey choices are available: UIp-p, MASK, XFR50%, and XFR75%. If either the MASK, XFR50%, or XFR75% selection is enabled, that selection is displayed instead of the current amplitude.

The UIp-p softkey is used to manually specify a jitter amplitude. When pressed, three softkey choices are available: UP, DOWN, and HELP. The UP and DOWN softkeys increment or decrement the jitter amplitude by .02 UI, respectively; the HELP softkey gives instructions for entering a new amplitude from the MENU keypad. If the UIp-p softkey was previously enabled, the newly specified amplitude can be entered and implemented using the MENU keypad and the ENTER key, respectively.

9.2.3.3 Specifications

Reference Clock:	• Internal – 1.544 MHz ±5 ppm crystal oscillator. • Recovered from DS1 Wideband Jitter Option. • External BNC input: GEN CLK IN.
Frequency:	• 10.0 Hz - 40.0 kHz, ±0.1% (all waveforms). • 3-digit resolution.
Amplitude:	• 0 UI to 13 UI peak-to-peak. .02 UI resolution.
Modulation Accuracy:	• Sine wave – 10 Hz – 40 kHz, ±5% ±.05 UI. • Square, Triangle, and Ramp waves – 50 Hz – 5 kHz ±7% ±.06 UI.
Spectral Purity:	• Sine waves greater than or equal to 1.00 UI peak-to-peak; all spurious frequencies 30 dB minimum below fundamental.
External Modulation:	• BNC labeled JITTER MOD IN. • Impedance: 10 k ohms, AC coupled. • Calibration: 1.0 UI/volt. • Frequency response – ±5% ±.05 UI, 10 Hz to 40 kHz; greater than or equal to 20 dB/decade roll-off above 40 kHz.
Jittered Clock Output:	• Available on GEN CLK OUT BNC.

9.2.4 Masks

The FIREBERD 6000's DS1 jitter options fully reflect three industry-standard jitter masks and partially reflect two others. The specifications in CCITT Recommendation O.171 and Bell Technical Reference Publications PUB41451, PUB43801, and PUB62411 are all T1 standards which specify jitter characteristics for T1 equipment and systems. The masks are shown in Figure 9-3, along with the sine wave limit for the DS1 Jitter Generation option.

The mask values are used by the DS1 Jitter Spectrum Analysis option to calculate the %MASK in each of the frequency bands. This measurement can be used to determine if the jitter on a T1 line exceeds the amount of jitter allowed by

the applicable mask. The mask values are also used by the DS1 Jitter Generation option to transmit the amount of jitter cited by a specific mask at the selected frequency.

The desired mask can be selected by setting the MENU switch to the JITTER category; pressing the MORE key causes the MASK, GRAPH, and LIST softkey labels to appear in the display. When the MASK softkey is pressed, the previously selected mask is displayed. To change masks, simply press the softkey associated with the desired mask.

The FIREBERD 6000's jitter options fully meet the specifications in CCITT Recommendation O.171, Bell PUB41451, and the 1983 issue of Bell PUB62411. The specifications in Bell PUB43801 and the 1985 issue of Bell PUB624II are met where those masks are less than 13 UI and between 10 Hz and 40 kHz. Since the Jitter Generation option only operates to 13 UI, any mask that exceeds this value is truncated to 13 UI. The Spectral Analysis option does generate a proper %MASK value for these points in the mask if the jitter measured is within its measurement range.

9.3 G.703 JITTER GENERATION AND MEASUREMENT

This section describes G.703 jitter generation and measurement, specifically:

- G.703 Jitter Generation and Wideband Measurement (Option 6007)
- G.703 Jitter Spectral Analysis (Option 6008)

These options are used with either the G.703 64 kb/s Data Interface (Model 30608) or the G.704 2048 kb/s Framing Interface (Model 30609). The presence of G.703 Jitter Generation and Wideband Measurement (Option 6007) is required for the G.703 Jitter Spectral Analysis (Option 6008) to be installed. (Both options operate simultaneously.)

Jitter on a digital line is the displacement in time of a data pulse from its ideal position. Two parameters are used to characterize jitter. The first is the amplitude of the phase displacement, which varies over time. The amplitude is measured in unit intervals (UI), where one UI is equal to the amount of time associated with one data bit period, or 488 nanoseconds at 2048 kb/s and 15.63 microseconds at 64 kb/s. The second parameter is the frequency at which the amplitude is changing measured in Hertz (Hz).

The G.703 Jitter Generation and Wideband Measurement option measures jitter over a wide frequency band (20 Hz to 30 kHz for 64 kb/s; 20 Hz to 100 kHz for 2048 kb/s). This measurement follows the guidelines set forth in CCITT Recommendation O.171. The jitter modulator can apply a sine, square, ramp, or triangle wave jitter signal to an internal, external, or recovered reference clock signal. Discussion of the two functions of the G.703 Jitter Generation and Wideband Measurement option is split into two sections: Section 9.3.1, Jitter Wideband Measurement; and Section 9.3.3, Jitter Generation.

The G.703 Jitter Spectral Analysis option performs multiple-band spectrum analysis on the wideband jitter; this option is discussed in Section 9.3.4.

9.3.1 G.703 Jitter Wideband Measurement

The G.703 Jitter Generation Wideband Measurement option (Option 6007) receives a jittered clock signal from either the G.703 64 kb/s Data Interface (Model 30608) or the G.704 2048 kb/s Framing Interface (Model 30609). It then demodulates the jittered clock and makes the following measurements.

- Peak-to-peak jitter (1SEC JTR)
- Maximum peak-to-peak jitter (MAX JTR)
- Jitter hits count (JTR HITS)

9.3.1.1 Functional Description

The G.703 Jitter Generation and Wideband Measurement option demodulates the jittered clock by generating a voltage that is proportional in amplitude to the amplitude of the phase displacement. This signal is bandwidth-limited based upon the RANGE selection (BAND1; BAND2) and the bit rate. Once it is converted to analog voltage, the jitter signal is sent to the measurement circuitry on the G.703 Jitter Generation and Wideband Measurement option and to the G.703 Jitter Spectral Analysis option (if installed).

In G.703 Jitter Generation and Wideband Measurement, peak-to-peak measurement circuitry tells the FIREBERD 6000 how many unit intervals of jitter are being received. The analog jitter signal is also buffered and sent to the rear panel BNC connector labeled DEMOD JITTER OUT.

The G.703 Jitter Generation and Wideband Measurement option also measures jitter hits. A jitter hit occurs when the instantaneous jitter exceeds a user-selectable threshold. It is the absolute value of the demodulated jitter that is measured. Therefore, both positive and negative jitter maxima are compared to the chosen jitter hit threshold.

9.3.1.2 Operation

Figure 9-4 shows the menu tree for all of the G.703 jitter options. The menu tree is accessed by pressing the MENU

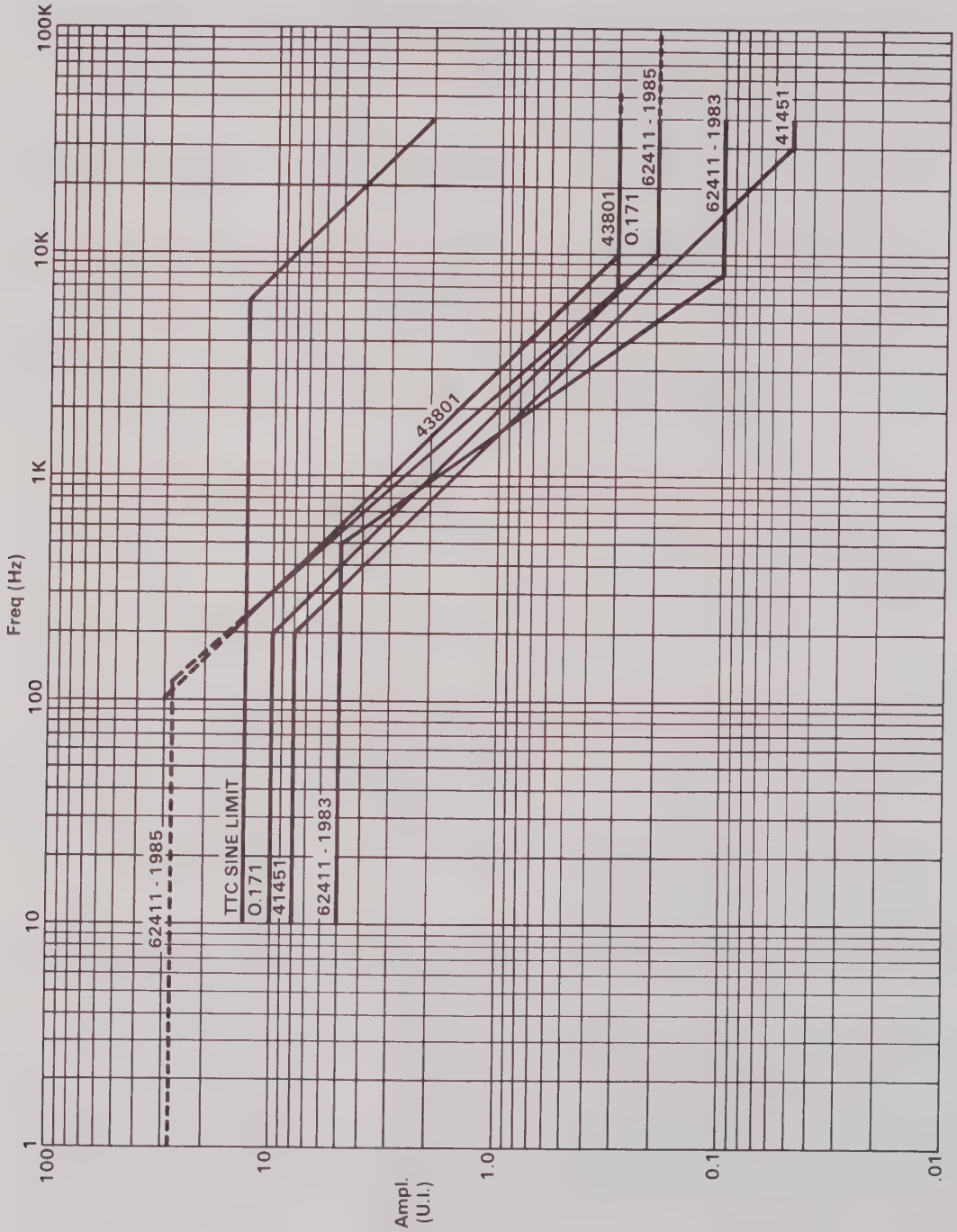


Figure 9-3
Jitter Masks

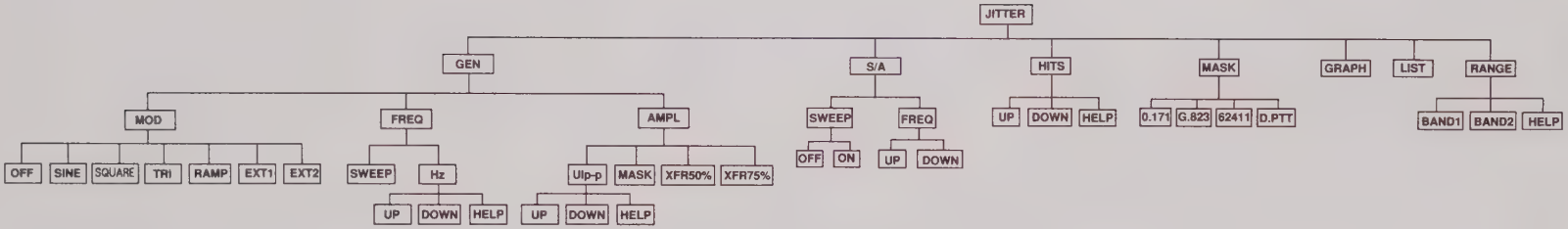


Figure 9-4
G.703 Jitter Menu

pushbutton switch to the JITTER position. The Wideband Jitter Measurement modes are accessed by pressing the RANGE softkey. Three more selections then appear in the display: BAND1, BAND2, and HELP. The RANGE specified affects both the amplitude and the frequency range of the jitter measured. Table 9-3 lists the RANGE specifications; the HELP softkey also offers a condensed version of this table.

The jitter results 1 SEC JTR, MAX JTR, and JTR HITS are found in the SIGNAL category of results. The 1 SEC JTR result is the maximum jitter measured over the last second. The MAX JTR result is the maximum of the 1 SEC JTR results since the last test restart. The JTR HITS result is the number of jitter hits that have been counted since the last test restart. These results are not accessible if the Jitter Generation and Wideband Measurement option is not installed, or if an incorrect interface is installed.

Pressing the HITS softkey in the JITTER menu allows the user to set the jitter hits threshold. (The HITS softkey is accessed by pressing the MORE softkey.) The user may enter a hits threshold from the keypad, or may scroll to the desired hit threshold using the UP and DOWN softkeys. When pressed, the HELP key displays a range of valid values for the hit threshold based on the currently selected frequency band.

9.3.1.3 Specifications

The specifications for G.703 wideband jitter measurement and G.703 jitter hits measurement are shown in Tables 9-3 and 9-4, respectively.

9.3.2 Masks

The FIREBERD 6000 has a preprogrammed function which can allow the jitter generator's amplitude to be set as a function of the jitter frequency and the selected mask. (See Section 9.3.3 for jitter generation operation.) The masks found in CCITT Recommendations O.171 and G.823 specify jitter characteristics for G.703 equipment and systems. The masks are shown in Figures 9-5 and 9-6.

The mask values are used by the G.703 Jitter Spectral Analysis option (Section 9.3.4) to calculate the %MASK in each of the frequency bands. This measurement can be used to easily determine if the jitter on the digital signal exceeds the amount of jitter allowed by the applicable mask.

The desired mask can be selected by pressing the MENU pushbutton switch to select the JITTER function; pressing the MORE key causes the MASK, GRAPH, and LIST softkey labels to appear in the display. When the MASK softkey is pressed, the previously selected mask is displayed. To change masks, simply press the softkey under the desired mask.

9.3.3 G.703 Jitter Generation

The G.703 Jitter Generation and Wideband Measurement option can phase-modulate the FIREBERD 6000 transmit clock with an internally generated waveform, an external waveform, or a combination of both to transmit jittered data from the G.703 64 kb/s Data Interface and the G.704 2048 kb/s Framing Interface. Jitter can be added to an internal clock, external clock, recovered clock, and looped-thru data. The following list summarizes the features of the G.703 Jitter Generation option.

Frequency:
- User-selectable frequency, 3-digit resolution
- Automatic sweep

Amplitude:
- User-selectable amplitude
- Can automatically set to selected mask level
- Can automatically set to 50% or 75% of the selected mask level

Modulation:
- Sine
- Square
- Triangle
- Ramp
- External

Clock:
- Internal
- External
- Recovered

9.3.3.1 Functional Description

The G.703 Jitter Generation and Wideband Measurement option can apply jitter to a digital signal by phase-modulating the digital signal with another waveform. This waveform can be externally supplied or internally generated by the G.703 Jitter Generation and Wideband Measurement option.

There are three clock sources which may be used with the jitter generator. When internal timing is selected, jitter is applied to an internal reference. (The frequency synthesizer is used to set the frequency of the modulating waveform.) An external clock source can be supplied to the FIREBERD's GEN CLK IN rear panel BNC connector. The third clock source is the recovered clock from the receiver of the interface in use; this clock source is generally used when jitterizing looped data.

There are three parameters to be selected with the G.703 Jitter Generation option: modulation type, frequency, and amplitude. The waveform synthesizer on the G.703 Jitter

Table 9-3
G.703 Wideband Jitter Measurement Specifications

Interface	Band	40 dB/decade High Pass Filter -3 dB Point	Low Pass Filter Passband	60db/decade Measurement -3 dB Point	Passband Range	Data Rate Resolution	Passband Accuracy	Tolerance
2048 kb/s	Band 1	2 Hz	20 Hz—27 kHz	54 kHz	12.00 UI p-p	0.01 UI p-p	±5 ± .040 UI p-p	±50 ppm
	Band 2	2 Hz	20 Hz—100 kHz	200 kHz	1.200 UI p-p	0.005 UI p-p	±5 ± .035 UI p-p	±50 ppm
64 kb/s	Band 1	2 Hz	20 Hz—5 kHz	10 kHz	1.500 UI p-p	0.005 UI p-p	±5% ±.010 UI p-p	
	Band 2	2 Hz	20 Hz—10 kHz	0.200 UI p-p	0.005 UI p-p	0.005 UI p-p	±5% ± .009 UI p-p	

Table 9-4
G.703 Jitter Hits Measurement Specifications

Interface	Band	Range	Step Size	Accuracy
2048 kb/s	Band 1	0.1—6.0 UI p-p	0.10 UI	±7% ± 0.02 UIp
	Band 2	0.05—0.60 UIp	0.05 UI	±7% ± 0.02 UIp
64 kb/s	Band 1	0.05—0.75 UIp	0.05 UI	±7% ± 0.005 UIp
	Band 2	0.05—0.15 UIp	0.05 UI	±7% ± 0.005 UIp

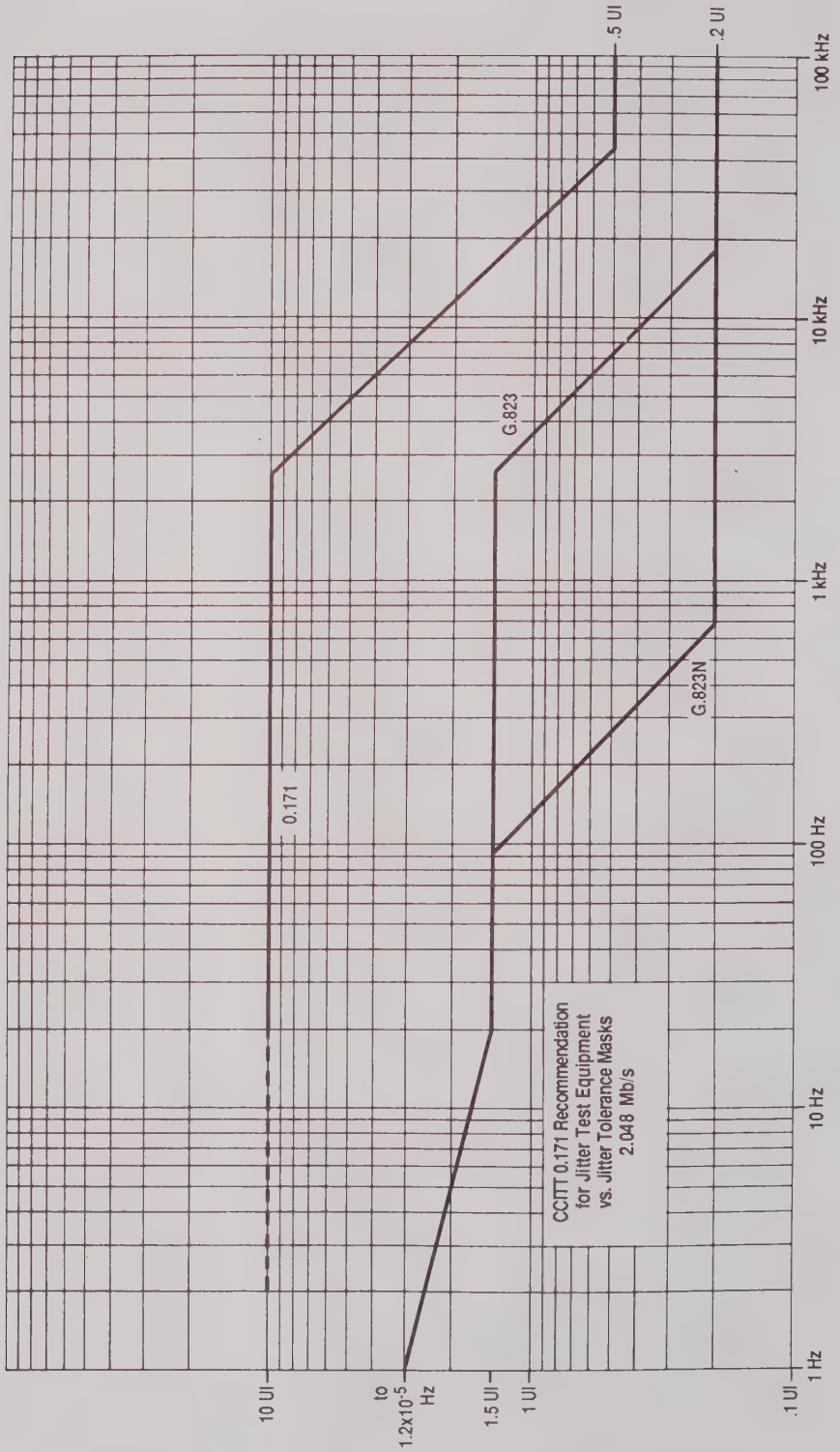


Figure 9-5
CCITT Jitter Masks

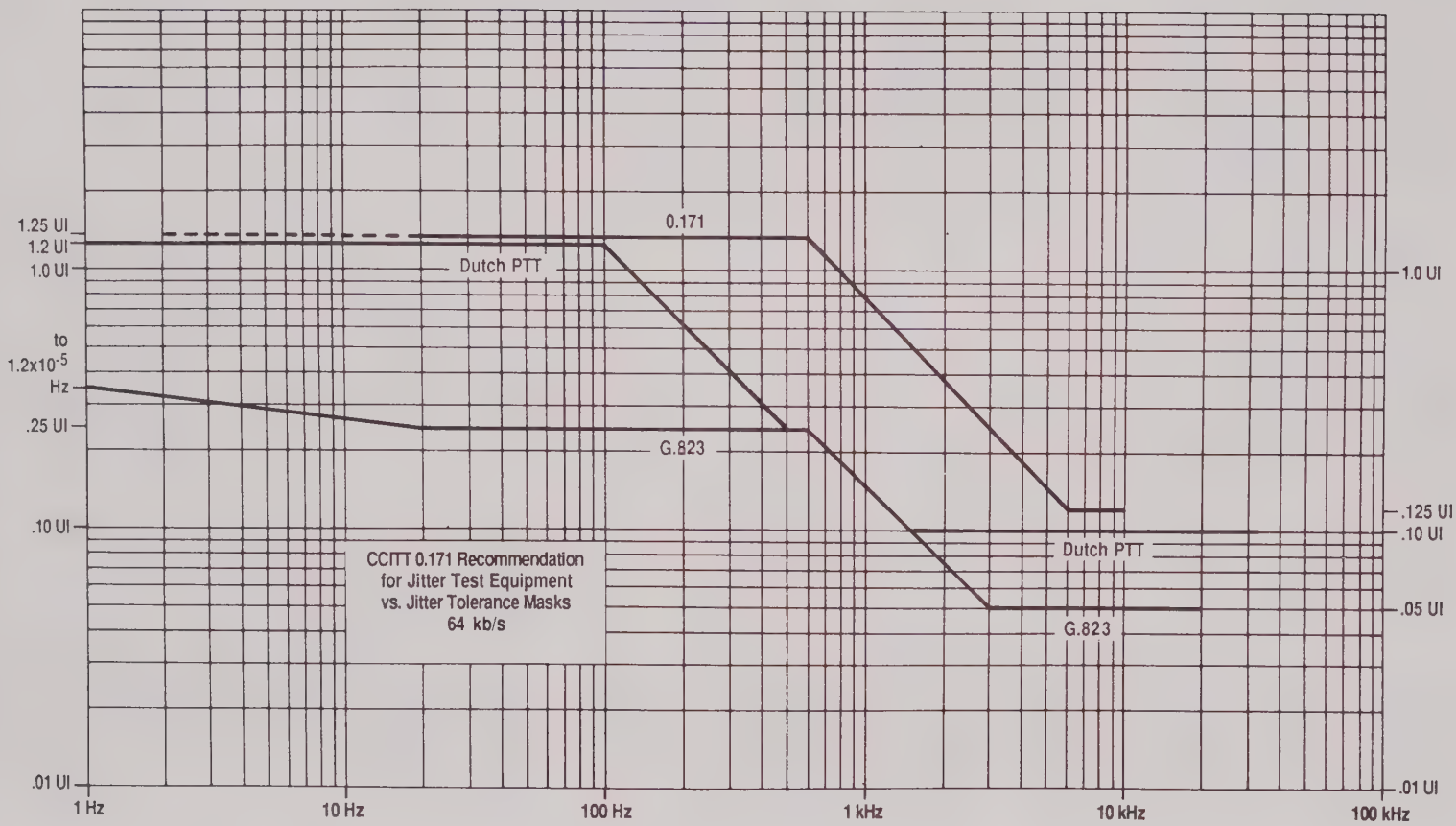


Figure 9-6
CCITT Jitter Masks

Generation option can generate a sine, square, ramp, or triangle wave. When any one of these waveforms is selected, it is added to the external waveform, allowing the jitter signal to be extremely versatile. The external signal can also be selected to be the only modulation signal used. If the modulation is turned off, the jitterable clock is no longer the FIREBERD 6000's timing source.

The FIREBERD 6000's frequency synthesizer is used to generate the jitter modulation frequency. The modulation frequency can be selected with 3-digit resolution from 2.00 Hz to 100 kHz at 2048 kb/s, and from 2.00 Hz to 32.0 kHz at 64 kb/s. As an alternative to fixed-frequency jitter modulation, a jitter generation sweep can be used, sweeping through the 58 (37 at 64 kb/s) points listed in Table 9-7. Jitter is generated at each frequency for approximately 1 second, unless the G.703 Spectral Analysis option is installed and used in Sweep mode.

The jitter amplitude, either with or without the jitter generator sweep enabled, can be selected manually or can be automatically referenced to the selected jitter mask. The amplitude can be set to MASK, which will set the amplitude of the generated jitter to the level specified by the selected mask for the current jitter frequency. This may be used with the jitter sweep to perform jitter tolerance tests. The jitter generator amplitude can also be set to XFER, which sets the amplitude of the generated jitter to half of the jitter specified by the mask for the current jitter frequency. This may be used with the jitter sweep to perform jitter transfer characteristic tests.

9.3.3.2 Operation

The FIREBERD 6000's front panel GEN CLK switch selects the clock source that is phase-modulated by the G.703 Jitter Generation and Wideband Measurement option. When the GEN CLK switch is set to the SYNTH position, an internal reference is selected for jitter modulation. Note that the frequency synthesizer is not selected as the clock source; it is instead used to generate the jitter modulation frequency. Therefore, the message **SYNTH DEFAULTS TO 2048 (64) kHz WITH JIT GEN** is displayed when the SYNTH menu is selected.

When the GEN CLK switch is in the BNC position, the GEN CLK IN rear panel BNC connector is selected as the clock source.

NOTE: The jitter generator expects a 2.048 MHz clock regardless of the interface in use. When selecting the BNC input as the source of generator timing for the G.703 64 kb/s Data Interface, the external source must be set to 2048 kHz when jitter generation is on and to 64 kHz when jitter generation is off.

When the GEN CLK switch is set to the INTF position, the dejitterized, recovered G.703 or G.704 clock is selected.

The rest of the jitter generation functions are accessed through the JITTER menu tree (see Figure 9-4). Pressing the GEN softkey accesses the top level of the jitter generation menu; at this level, the frequency and amplitude displayed reflect the actual amount of jitter being generated. When a contention occurs, these actual amounts may differ from the values which the user has selected. A contention occurs when the amplitude selected is greater than the amplitude that can be generated at the selected frequency; a message is displayed to indicate that a contention exists.

NOTE: At lower levels in the menu, the display always shows the frequency and amplitude values selected by the user, rather than the frequency and amplitude of the jitter actually being generated. Likewise, when a contention occurs at these lower menu levels, a message is displayed to indicate that a contention exists. To view the actual amount of jitter being generated, the user must return to the top level (GEN softkey) of the menu.

The modulation type may be selected by pressing the MOD softkey. If the modulation is set to Off, the selected generator clock is not modulated and the jitter generator is removed from the FIREBERD 6000's timing path. If the modulation is set to EXT1 or EXT2, the external BNC connector labeled JITTER MOD IN is used as the modulation source. (EXT1 selects BAND 1; EXT2 selects BAND 2.) Figures 9-7 and 9-8 show the modulation limits for each band. The SIN, SQU, TRI, and RAMP softkeys represent the available internally generated waveforms, and the waveform that is selected is added to the external input and used as the modulation waveform.

Pressing the FREQ softkey accesses the softkeys SWEEP and Hz, which are used to select the desired frequency. If the SWEEP softkey was previously selected, the message SWEEP is displayed instead of the current frequency. Pressing the Hz softkey turns the sweep off and allows the desired frequency to be entered; the last frequency entered is displayed, as are the softkeys UP, DOWN, and HELP.

The UP and DOWN softkeys step through the frequencies corresponding to the spectrum analyzer's bands, and the HELP softkey gives instructions for entering a new frequency from the keypad. If the Hz softkey was previously selected, the current jitter generator frequency is displayed and a new frequency can be entered by using the keypad and then pressing the ENTER key.

The AMPL softkey accesses the softkeys MASK, UI p-p, and XFER, which allow the desired amplitude to be selected. If either the MASK or XFER softkeys was previously selected,

then MASK or XFER is displayed instead of the current amplitude. Pressing the UI p-p softkey turns off the MASK or XFER function; the last amplitude entered is displayed, and softkeys labeled UP, DOWN, and HELP are displayed. The UP and DOWN softkeys increment or decrement the jitter amplitude by the minimum increment allowed at the bit rate in use, and the HELP softkey gives instructions for entering a new amplitude from the keypad. If the UI softkey was previously selected, the current jitter generator amplitude is displayed and a new amplitude can be entered by using the keypad and the pressing the ENTER key.

NOTE: If the UI softkey has been selected, the amplitude can be entered directly from the top level (AMPL softkey) of the menu.

9.3.3.3 Specifications

Jitter Generator Amplitude:
- See Table 9-5.

Jitter Generator Internal Generator Frequency:
- See Table 9-6.

External Modulation:
- BNC labeled JITTER MOD IN.
- Impedance: 10 k-ohms ±5%; DC coupled.

Maximum Input:
- ±25 volts.

Reference Clock Sources:
- Internal: ±5 ppm, 4.096 MHz crystal oscillator.
- Recovered: Dejittered clock.
- External BNC Input: GEN CLK IN; 50 ohm (resistive termination); 1.5V p-p or greater unipolar or bipolar signal.

Jittered Clock Output (BNC):
- GEN CLK OUT, 50 ohm load minimum; TTL level; 50 +5% duty cycle square wave.

2048 kb/s Generator Sweep:
- The sinewave generator may be set up to automatically sweep through a number of frequencies with jitter amplitudes defined by one of the following jitter masks: O.171, G.823, or G.823N (see Figure 9-5).

64 kb/s Generator Sweep:
- The sinewave generator may be set up to automatically sweep through a number of frequencies with jitter amplitudes defined by one of the following jitter masks: O.171, G.823, or Dutch PTT (see Figure 9-6).

Mask Sweep:
- Jitter amplitude equals that defined by mask.

Transfer Characteristic Sweep:
- Equals one-half or three-quarters of the jitter amplitude defined by mask.

Table 9-5
G.703 Jitter Generation Amplitude Specifications

	Sinusoidal Modulation				Non-Sinusoidal Modulation		
Interface	1.0 UI=	Maximum	Resolution	Accuracy	Maximum	Resolution	Accuracy
2048 kb/s	488 ns.	12.0 UI p-p	0.02 UI p-p	±5% ±0.05 UI p-p	10.00 UI p-p	0.02 UI p-p	±7% ± 0.05 UI p-p
64 kb/s	15.63 ms.	1.500 UI p-p	0.005 UI p-p	±5% ±0.013 UI p-p	1.250 UI p-p	0.005 UI p-p	±7% ±0.013 UI p-p

Table 9-6
G.703 Jitter Generator Internal Generator Frequency Specifications

Interface	Sinusoidal Modulation Range	Non-Sinusoidal Modulation Range	Resolution	Accuracy
2048 kb/s	2.0 Hz—100 kHz	50.0 Hz—5.00 kHz	3 significant digits	±0.1% of setting
64 kb/s	2.0 Hz—32.0 kHz	50.0 Hz—1.00 kHz	3 significant digits	±0.1% of setting

9.3.4 G.703 Jitter Spectral Analysis Option

The G.703 Jitter Spectral Analysis option (Option 6008) consists of a board that plugs into the G.703 Jitter Generation and Wideband Measurement option. At 2048 kb/s, the spectrum analyzer measures the maximum peak-to-peak jitter in 58 frequency bands from 10 Hz to 100 kHz and displays the result in unit intervals (UI). At 64 kb/s, the spectrum analyzer measures the maximum peak-to-peak jitter in 37 frequency bands from 10 Hz to 30 kHz and displays the result in UI. Refer to Table 9-7 for a list of the frequency bands.

The G.703 Jitter Spectral Analysis option enables the following measurements.

- Jitter amplitude measured in UI peak-to-peak with a continuous sweep of 58 (37 at 64 kb/s) frequency bands.
- Continuous jitter amplitude measurement in UI peak-to-peak at one frequency.
- Percent of mask for each band.

The G.703 Jitter Spectral Analysis option can only be used with the G.703 Jitter Generation and Wideband Measurement option.

9.3.4.1 Functional Description

The G.703 Jitter Spectral Analysis option is offered with the FIREBERD 6000 to allow the user to determine the frequency content of timing jitter in a digital system. This is accomplished by filtering the wideband jitter signal obtained from the G.703 Jitter Generation and Wideband Measurement option into 58 (37 at 64 kb/s) discrete frequency bands. The output of each filter in turn goes to a peak-to-peak measurement circuit. The G.703 Jitter Spectral Analysis option can either (1) continuously monitor one of the frequency bands and measure the jitter amplitude for that band, or (2) continually sweep through the frequency bands. When the sweep is enabled, the amplitude stored and displayed for each frequency band is the maximum amplitude value recorded since the last test restart.

The sweep function of the G.703 Jitter Spectral Analysis option operates synchronously with the generator sweep function of the G.703 Jitter Generation and Wideband Measurement option. The G.703 jitter generator generates jitter at a specific frequency, the spectrum analyzer measures that frequency band, and both options will increment to the next frequency band. This capability can be used to test equipment for bit errors or jitter attenuation characteristics. (See the Functional Description in Section 9.3.3.1 for more information.)

The time required to complete one sweep of the spectrum analyzer is approximately 45 to 50 seconds with jitter generation disabled, and approximately 2 to 2 1/2 minutes with jitter generation enabled.

Care should be exercised in comparing the spectral analysis results. The Wideband Jitter option makes continuous measurements over the entire frequency range for 64 kb/s and 2048 kb/s. The result obtained with that option is a true indication of the overall maximum jitter in that band. This is in contrast to the spectrum analyzer which looks at a much narrower bandwidth for each measurement. Real-world jitter is likely to be non-sinusoidal, containing frequency components that do not add directly. As a result, it is important that the wideband measurement be used with the spectrum analyzer measurements in determining system performance.

Since the Spectral Analysis Option (6008) uses the signal from the G.703 Jitter Generation and Wideband Measurement Option (6007), the RANGE selection affects the amount of jitter that can be measured by Option 6008. In both BAND 1 and BAND2, however, the Spectrum Analysis functions cover the full frequency range for the interface in use.

9.3.4.2 Operation

The G.703 Jitter Spectral Analysis measurement modes are accessed in the JITTER menu tree (see Figure 9-4) by pressing the S/A softkey. At this level in the menu, the current frequency and the measured amplitude at that frequency are displayed. If the sweep is disabled, the frequency displayed is the only one for which measurements are taken. The display is updated each time the amplitude measurement is completed. If the sweep is enabled, the frequency displayed sweeps along with the measurement, which allows the user to know the status of the sweep at any point in time. In addition, the amplitude displayed for each frequency is the maximum amplitude measured in that band since the last test restart.

Pressing the SWEEP softkey causes the selections ON and OFF to be displayed; selecting either the ON or OFF softkey places the sweep function in the corresponding state. Pressing the FREQ softkey accesses the softkeys UP and DOWN, which can be used to scroll through the frequency bands. When the sweep is enabled, the amplitude displayed is the maximum value stored for that band. When the sweep is disabled, either of the UP or DOWN softkeys changes the frequency band currently being measured to the band selected by the softkey.

The following results are available under the ANALYSIS RESULTS function of the SIGNAL category for G.703 Jitter Spectral Analysis:

1. Maximum % of Mask (%MASK)

   Each time the jitter spectrum analyzer takes a reading, the ratio of the measured jitter amplitude to the reference jitter mask's value at this point is calculated. If the spectrum analyzer is sweeping, then the maximum value of that ratio since the beginning of the test is displayed as a percentage, and a value less than 100% indicates that during the test no spectrum analyzer reading exceeded the reference mask. If the spectrum analyzer is not sweeping, then the ratio of the last spectrum analyzer reading to the reference mask at that frequency is displayed as a percentage.

2. S/A X.XX k

   The amplitude of the jitter at the frequency currently measured by the spectrum analyzer. If the spectrum analyzer sweep is enabled, this result sweeps also.

When the PEAK softkey is pressed, the PEAKUP and PEAKDN softkeys allow the user to quickly find any peaks in the spectrum when the sweep is enabled. A peak is defined as those bands where the jitter is worst in relation to the selected jitter mask. The PEAKUP softkey finds the next higher frequency jitter peak and the PEAKDN softkey finds the next lower frequency jitter peak. Since there are no peaks when the sweep is disabled, the PEAK softkey is not visible if the sweep is off.

Pressing the LIST softkey in the JITTER menu sends a list of the jitter spectrum analyzer frequency band measurements and their corresponding %MASK values to the printer port. If the jitter spectrum analyzer sweep is turned off, only one frequency in the list is printed and the others remain blank.

Pressing the GRAPH softkey in the JITTER menu generates a graph of the G.703 Jitter Spectral Analysis results. The graphics are Epson-compatible and can be used with TTC's PR-85 Printer. The results are graphed only when the jitter spectrum analyzer sweep is on.

9.3.4.3 Specifications

Frequency Points/
Measurement Bandwidths:
- See Table 9-7.

Filter Bandwidths:
- See Figure 9-2 and Table 9-2.

Range:

2048 kb/s
- BAND 1 — Up to 12.00 UI p-p.
- BAND 2 — Up to 1.200 UI p-p.

64 kb/s
- BAND 1 — Up to 1.500 UI p-p.
- BAND 2 — Up to 0.300 UI p-p.

Resolution:

2048 kb/s

- BAND 1 — 0.00 to 2.00 UI p-p in 0.01 UI p-p steps; 2.00 to 12.00 UI p-p in 0.05 UI p-p steps.
- BAND 2 — 0.000 to 0.500 UI p-p in 0.005 UI p-p steps; 0.500 to 1.200 UI p-p in 0.025 UI p-p steps.

64 kb/s

- BAND 1 — 0.000 to 0.250 UI p-p in 0.005 UI p-p steps; 0.250 to 1.500 UI p-p in 0.025 UI p-p steps.
- BAND 2 — 0.000 to 0.050 UI p-p in 0.005 UI p-p steps; 0.050 to 0.300 UI p-p in 0.025 UI p-p steps.

Accuracy:

2048 kb/s

- BAND 1 — ±10% ±0.08 UI p-p.
- BAND 2 — ±10% ±0.05 UI p-p.

64 kb/s

- BAND 1 — ±10% ±0.02 UI p-p.
- BAND 2 — ±10% ±0.013 UI p-p.

Table 9-7
Frequency Points and Measurement Bandwidths

10 Hz BW	33 Hz BW	100 Hz BW	333 Hz BW	1 kHz BW	3.3kHzBW
10 Hz	100 Hz	300 Hz	1.00 kHz	3.00 kHz	10.0 kHz
20 Hz	133 Hz	400 Hz	1.33 kHz	4.00 kHz	13.3 kHz
30 Hz	166 Hz	500 Hz	1.66 kHz	5.00 kHz	16.6 kHz
40 Hz	200 Hz	600 Hz	2.00 kHz	6.00 kHz	20.0 kHz
50 Hz	233 Hz	700 Hz	2.33 kHz	7.00 kHz	23.3 kHz
60 Hz		800 Hz		8.00 kHz	26.6 kHz
70 Hz					30.0 kHz*
80 Hz					33.3 kHz
					36.6 kHz
					40.0 kHz
					43.3 kHz
					46.6 kHz
					50.0 kHz
					53.3 kHz
					56.6 kHz
					60.0 kHz
					63.3 kHz
					66.6 kHz
					70.0 kHz
					73.3 kHz
					76.6 kHz
					80.0 kHz
					83.3 kHz
					86.6 kHz
					90.0 kHz
					93.3 kHz
					96.6 kHz
					100.0 kHz

*Stop here at 64 kb/s.

SECTION 10
SPECIFICATIONS

10.1 MODES OF OPERATION

Emulation:
- Emulate DTE mode (for connection to DCE).
- Emulate DCE mode (for connection to DTE).

System Configuration:
- Full-Duplex mode.
- Single Transmit mode.
- Self-Loop mode.

Timing Modes:
- Synchronous Timing.
- Asynchronous Timing.
- Recovered Timing (optional).

10.2 GENERATOR

10.2.1 Generator Timing Systems

Timing Modes:
- Synchronous (1x bit rate clock generated for bit rates from 50 to 15,000,000 b/s).
- Asynchronous (16x bit rate clock used by USART for bit rates from 50 to 20,000 b/s).
- Recovered (1x bit rate clock generated for bit rates from 50 to 520,000 b/s).

Timing Sources:
- Internal frequency synthesizer.
- GEN CLK IN rear panel BNC connector.
- Data interface.

Indicator:
- LED within the GEN CLK switch illuminates when no generator clock signal is present.

10.2.1.1 Frequency Synthesizer

Frequency Range:
- 50.00 Hz to 15.000 MHz (16x bit rate clock generated in the 16x Asynchronous timing mode for bit rates from 50 to 20,000 b/s).

Resolution:
- 5 significant digits (for frequencies that begin with 10 through 15).
- 4 significant digits (all other frequencies).

Accuracy and Stability:
- ±5 ppm (±1 ppm optional).
- ±5 ppm/year (±1 ppm/year optional).

10.2.1.2 GEN CLK IN Rear Panel BNC Connector

Input Configuration
- Outer conductor — ground.
- Inner conductor — signal.

Input DC Impedance:
- 1000 ohms.

Input AC Impedance:
- 50 ohms.

Input Signal Range:
- 1.5 volts p-p to 25 volts p-p.

10.2.1.3 GEN CLK OUT Rear Panel BNC Connector

Output Configuration:
- Outer Conductor — ground.
- Inner Conductor — signal.

Output Load:
- 50 ohms minimum.

Output Signal Levels:
- TTL Levels - 2.0 volts minimum high level, 0.4 volts maximum low level (50-ohm load).

10.2.2 Data Generator

Fixed Patterns:
- Mark.
- 1:1.
- User-programmable, 3- to 24-bit repeating pattern.
- 1:7.
- 3-in-24.
- DDS-1/DDS-5 (DDS-specific patterns)
- T-1/T-6 and T1 - mW (T1 - specific patterns)

Pseudorandom Patterns:
- 63 (2^6-1).
- 511 (2^9-1).
- 2047 (2^{11}-1).
- 2^{15}-1 (32, 767).
- 2^{20}-1 (1,048, 575).
- 2^{23}-1 (8, 388, 607).
- QRSS.

Messages:
- FOX Message (in Baudot, BCDIC, ASCII, or EBCDIC depending on code level selected).
- Three user-programmable messages each up to 2048 characters in length.

Character Format (Asynchronous Timing mode):
- Code Level 5, 6, 7, 8 bits.
- Parity — odd, even, none.
- Stop Bits — 1, 1.5, 2 bits.

Data Inversion:
- Available by Auxiliary Function for transmitted data.

Error Insertion:
- Single error or fixed 10^{-3} bit error rate in generated data only.

Full-Duplex Bit Rates:
- Messages and/or Asynchronous timing mode — 50 to 20,000 b/s.
- Synchronous timing mode — 50 to 15,000,000 b/s.

10.3 RECEIVER

10.3.1 Receiver Timing Systems

Timing Modes:
- Synchronous (1x bit rate clock received through data interface for bit rates from 50 to 15,000,00 b/s).
- Asynchronous (16x bit rate clock internally provided for USART for bit rates from 50 to 20,000 b/s).
- Recovered (1x bit rate clock recovered from data transitions for bit rates from 50 to 520,000 b/s).

Timing Sources:
- Data interface.
- Clock Recovery option.

Indicators:
- NO CLK backlit label illuminates when receiver clock is not present.
- CLK INV backlit label illuminates when the clock-data phasing at the input of data interface is the opposite of that required by the applicable interface standard.

10.3.2 Data Error Analysis

Analysis Modes:
- Single.
- Continuous.

Indicators:
- Receiver Inputs:
  - — MK indicator illuminates when a Mark is received by the FIREBERD.
  - — SP indicator illuminates when a Space is received by the FIREBERD.
  - — SYNC indicator illuminates when pattern sync is achieved.
- DATA INV backlit indicator illuminates when the data received by the FIREBERD is inverted from what is expected.
- SYNC LOST LED (latching with pushbutton reset) is illuminated when a sync loss occurs.

Sync Acquisition Criteria (Synchronous, Recovered timing modes):
- Fixed pattern data — 30 consecutive bits with no errors.
- Pseudorandom pattern data — 30 + n consecutive bits with no errors for a 2^n-1 pattern.
- User-programmable messages — dependent upon Auxiliary Function 45.

Sync Acquisition Criteria (Asynchronous timing mode):
- Fixed pattern data, pseudorandom pattern data, and messages — 10 consecutive characters with no errors.

Sync Loss Criteria (Synchronous, Recovered timing modes):
- Medium Sync Loss Threshold 250 bit errors in less than 1000 bits of data.
- Low Sync Loss Threshold 100 bit errors in less than 1000 bits of data.
- High Sync Loss Threshold 20,000 bit errors in less than 100,000 bits of data.

Sync Loss Criteria (Asynchronous timing mode):
- Low and Medium Sync Loss Thresholds — 30 character errors in less than 60 received characters.
- High Sync Loss Threshold — 20,000 bit errors in less than 100,000 received bits.

10.3.2.1 Error Analysis

Test Results Available: (with appropriate data interface)
- Bit Errors.
- Average Bit Error Rate.
- Bit Error Rate (BER).
- Blocks.
- Block Errors.
- Average Block Error Rate.
- Character Errors.
- Pattern Slip.

10.3.2.2 Time-Related Result

Test Results Available: (with appropriate data interface)
- Errorred Error Analysis Seconds.
- Error Analysis Seconds.
- Error-Free Error Analysis Seconds.
- Elapsed Seconds.
- Time.
- Date.
- % Pattern Seconds.
- Pattern Synchronization Loss Seconds
- Signal Loss Seconds
- % Active Seconds

10.3.2.3 Performance Analysis

Test Results Available: (with appropriate data interface)
- G.821 Errored Seconds.
- G.821 Error-Free Seconds.
- G.821 % Error-Free Seconds
- Degraded Minutes.
- % Degraded Minutes
- Severely Errored Seconds
- % Severely Errored Seconds
- G.821 Violation-Free Seconds
- G.821 % Violation-Free Seconds
- Unavailable Seconds
- Available Seconds
- Severely Violated Seconds
- % Severely Violated Seconds

10.3.2.4 BER Test Intervals

- 10^4, 10^5, 10^6, 10^7, 10^8, 10^9, or 10^{10} bits.
- Timed Tests Intervals — 1 second to 24 hours, 1-second resolution.

10.3.2.5 Block Lengths

- 10^2 to 10^6 bits, 1-bit resolution.

10.3.3 Signal Analysis

10.3.3.1 Frequency Measurements

Frequency Range:
- 50 Hz to 16 MHz.

Resolution:
- less than 1,000 Hz - 0.001 Hz.
- 1,000 Hz to 9,999.99 Hz - 0.01 Hz.
- 10,000.0 Hz to 99,999.0 Hz - 0.1 Hz.
- greater than 100,000 Hz - 1 Hz.

Accuracy:
- ±5 ppm (±1 ppm optional).

10.3.3.2 Delay Measurements

Start of Measurement Signal Sources:
- DTR.
- DSR.
- RTS.
- RLSD.
- CTS (emulate DCE only).
- Generator Data.
- Generator Pattern Sync test point.
- Delay Start test point.

End of Measurement Signal Sources:
- DTR.
- DSR.
- RTS.
- CTS (emulate DTE only).
- RLSD.
- Receiver Data.
- Receiver Pattern Sync test point.
- Delay Stop test point.

Edge Selection:
- Rising (off-to-on) or falling (on-to-off) edge selectable for both start and end of measurement signals (except pattern sync test points).

Measurement Range:
- 0 to 9,999.9 milliseconds.

Resolution and Accuracy:
- ± 0.1 millisecond.

10.3.3.3 ISDN Measurements

- Layer 2 Frame Errors.
- Frame Check Sequence Errors.

- Layer 2 Frame Abort.
- Number of Layer 2 Frames.
- Rejection Frames.
- Frame Rejection Frames.
- Power Feeding Status.
- Received Signal Level (Volts).
- Received Signal Level (dB).
- Transmitter INFO state.
- Receiver INFO state.
- TEI Assignment.
- Voice TEI.
- Data TEI.

10.3.4 T-Carrier Analysis

Test Results Available: (with appropriate data interface)

- Bipolar Violations.
- Average Bipolar Violation Rate.
- Bipolar Violation Rate.
- Code Errors.
- Average Code Error Rate.
- Code Error Rate.
- Violation-Free Error Analysis Seconds.
- % Violation-Free Error Analysis Seconds.
- Frame Errors.
- Average Frame Error Rate.
- Frame Error Rate.
- Frame Losses.
- CRC Errors.
- Average CRC Errors.
- CRC Error Rate.
- Frame Alignment Signal Errors.
- Average Frame Alignment Signal Error Rate.
- Frame Alignment Signal Error Rate.
- One-Second CRC Errors.
- Maximum Zeros.
- Bit Slips.
- Received Bit-Oriented Message.
- Received ABCD (RX ABCD).

10.3.5 Alarm

Test Results Available: (with appropriate data interface)

- Pattern Synchronization Losses.
- Data Losses.
- Clock Losses.
- Receiver Clock-Data Phase Changes.
- Power Losses.
- Signal Losses.
- Yellow Alarm Seconds.
- Excess Zero Seconds.
- Alarm Indication Signal Seconds.
- Ones Density Seconds
- Violated Frame Seconds.
- Remote Seconds

10.4 CLOCK RECOVERY SYSTEM

(With the Clock Recovery Option Installed)

Bit Rates:
- 50 b/s to 520 kb/s.

Clock Recovery Acquisition/ Tracking Range:
- ±1% of selected bit rate typical.

10.5 PROGRAMMABILITY

10.5.1 User-Defined Messages

Number of Programmable Messages:
- Three (USER 1, USER 2, USER 3).

Message Length:
- 2048 characters.

Entry Format:
- One hexadecimal character pair per transmitted character.

Output Format (Async):
- 5, 6, 7, or 8 level code.

10.5.2 Front Panel Programs

Number of Front-PanelPrograms:
- 10.

Functions Under User Program Control:
- Front panel switch settings,key-pad entries, auxiliary functions, etc.

Access:
- Program entry and program recall via the RECALL/STORE function of the MENU switch.

10.6 NON-VOLATILE MEMORY

Information Stored:
- Current front panel switch settings, keypad entries, auxiliary functions.
- Three user-defined messages.
- 10 front-panel programs.
- Time and date of last power-down.
- Results from before power-down.

Memory Back-up Battery Life:
- Typically greater than 7 years.

10.7 REMOTE CONTROL CAPABILITY

Remote Control Access:
- RS-232 Printer/Remote Control Interface.
- Optional IEEE-488 Interface.

Controllable Functions:
- Front panel switch settings.
- Keypad entries.
- Auxiliary functions.
- User-defined messages.

10.8 DATA INTERFACES

10.8.1 Built-In RS-232 Data Interface

Connectors:
- Two 25-pin D subminiature female connectors.
- One connector for DTE emulation labeled TO DCE.
- One connector for DCE emulation labeled TO DTE.

Signal Format:
- Bipolar, unbalanced.

Data Bit Rates:
- 50 to 20,000 b/s per EIA RS-232 and CCITT V.28.

10.8.2 External Data Interface

External Data Interface Slot:
- Accepts any FIREBERD data interface.

10.9 REAR PANEL TEST POINTS

Output Test points:
- Generator Clock.
- Generator Data.
- Generator Pattern Sync.
- Receiver Clock.
- Receiver Data.
- Receiver Pattern Sync.
- Error.
- Sync.
- Test Point Z.
- Signal Ground.

Logic Low Output:
- 0.4 volts maximum at 12 mA or less.

Logic High Output:
- 2.4 volts minimum at 3 mA or less.

Input Test Points:
- External Delay Start.
- External Delay Stop.

Logic Low Input:
- 0.8 volts maximum.

Logic High Input:
- 2.0 volts minimum.

Input Impedance:
- 2000 ohms minimum.

10.10 REAL TIME CLOCK

Display Clock Functions:
- Hours (24-hour format).
- Minutes.
- Seconds.
- Month.
- Day.
- Year.

Printed Clock Functions:
- Hours.
- Minutes.
- Seconds.
- Month.
- Day.
- Year.

Accuracy:
- Typically better than 1 second per day.

10.11 DISPLAY

Display Type:
- Vacuum Fluorescent Display.

Display Size:
- 80 characters — 40 characters x 2 lines.

Character Font:
- 5 x 7 dot matrix and cursor.

10.12 AUDIO OUTPUT

Audio Indicator:
- Speaker.

Audio Level Control:
- Volume control — off, minimum to maximum.

10.13 POWER REQUIREMENTS

Voltage:
- Two user selectable ranges: 90-135 VAC, 195-250 VAC.

Frequency:
- 48 to 66 Hz.

Power:
- 110 volt-amperes maximum.

10.14 ENVIRONMENTAL SPECIFICATIONS

Operating Temperature Range:
- 0 C (+32 F) to +50 C (l24 F).

Storage Temperature Range:
- 30 C (-22 F) to + 75 C (l67 F).

10.15 DIMENSIONS AND WEIGHT

FIREBERD 6000

Size:
- 6" H x 12" W x 12" D.

Weight:
- 15.8 lbs with all options, a data interface, and the IEEE-488 Remote Control Interface installed.

FIREBERD MC6000

Size:
- 6.5" H x 14.5" W x 14" D.

Weight:
- 19.3 lbs with all options. a data interface. and the IEEE-488 Remote Control Interface installed.

FIREBERD 6000R

Size:
- 6" H x 12" W x 12" D.

Weight:
- 12.0 lbs with all options. a data interface. and the IEEE-488 Remote Control Interface installed.

SECTION 11
OPTIONS AND ACCESSORIES

11.1 SECTION SUMMARY

This section describes some of the options and accessories available for use with the FIREBERD 6000. Specifically described are the Metal Case and Remote Control options and such accessories as the printers, rack mounts, and carrying cases. This section also includes, for ordering purposes, a list of all accessories available (including cables and data interfaces) with their corresponding model numbers.

11.2 OPTIONS

Various hardware and software options are available for the FIREBERD 6000. Two of these, the Metal Case option and the Remote Control option, are described below. The other available options are discussed in detail elsewhere in this manual. Section 11.2.3 lists these options and their model numbers.

11.2.1 FIREBERD MC6000 (Metal Case Option)

The FIREBERD MC6000 is the ruggedized version of the standard FIREBERD 6000. Performance characteristics, front and rear panel formats, and internal electronic subassemblies are identical.

The FIREBERD MC6000 housing is of metal construction and quite rugged. The unit comes with a front snap-on cover. With the cover in place, the instrument is completely protected and can be carried and handled like a piece of luggage. The manual or two extra interface modules can be stored in the snap-on back pouch.

The FIREBERD MC6000 is 6 1/2" high (including the feet), 14 1/2" wide and 14"deep (including the cover). The unit weighs approximately 19 pounds, 3 ounces with interface, all options, front cover, and power cord.

11.2.2 FIREBERD 6000R (Remote Control Communications Analyzer)

The FIREBERD 6000R has all of the capability of the FIREBERD 6000, but it will operate only under remote control. It is packaged in the FIREBERD 6000 plastic case but has a blank front panel with only a power switch and an indicator that lights while the FIREBERD is being remotely controlled. It weighs 12 pounds with all options, a data interface, and the IEEE-488 Remote Control Interface installed.

11.2.3 Options List

The following is a list of other available options and their part numbers. Listed in parentheses next to each option is the location in this manual of a description of the option.

Option Numbers	Descriptions
6001	DS1 Wideband Jitter Measurement (Section 9)
6002	DS1 Jitter Spectral Analysis (Section 9)
6003	DS1 Jitter Generation (Section 9)
6004	Clock Recovery (Section 5)
6005	IEEE-488 Remote Control/Printer Interface (Section 7)
6006	Precision Time Base (1ppm) (Section 5)
6007	G.703 64 kb/s and 2048 kb/s Wideband Jitter Generation and Measurement (Section 9)
6008	G.703 64 kb/s and 2048 kb/s Jitter Spectral Analysis (Section 9)

11.3 ACCESSORIES

Various accessories for the FIREBERD 6000 are described below. Also included are instructions for those accessories requiring installation.

11.3.1 PR-40A Printer

The PR-40A is an alphanumeric and graphics printer utilizing thermal dot matrix printing. The PR-40A features 40- and 80-column printing in a self-contained housing including complete control and interface electronics. It will also provide bit-mapped histograms and jitter graphics. It can be powered by a built-in nickel cadmium battery or through an AC adaptor. This compact and portable printer connects to the

RS-232 Printer/Controller Interface through a male-to-male printer cable.

For more information on the PR-40A printer, see the PR-40A Operating Manual.

11.3.2 PR-2000 Thermal Printer

The PR-2000 is a non-impact alphanumeric thermal printer. It is capable of printing the full ASCII character set with up to 20 characters per line. The characters are input in a serial asynchronous format with start, stop, and parity bits. The printer may be rack-mounted along with the FIREBERD in the RM-6000 or RM-MC 6000 Rack Mount units. A cable is included with each printer, allowing direct interface with the FIREBERD RS-232 Printer/Controller interfaces at 2400 baud.

For more information on the PR-2000 printer, see the PR-2000 Operating Manual.

11.3.3 ISU-2000 Interface Switching Unit

The Interface Switching Unit (ISU) allows the user to change data interfaces without physically removing and inserting them. The ISU is a rackmountable device that accommodates up to four data interfaces and electronically selects one data interface for use.

Intended to be rack mounted either directly above or directly below the FIREBERD, the Interface Switching Unit is connected to the FIREBERD by a ribbon cable attached to a special data interface (included). Switching between data interfaces can be accomplished by using pushbutton switches mounted on the ISU or remotely via contact closures. Indicators are provided on the ISU indicating which data interface is on line and whether the unit is under local or remote control.

The Interface Switching unit will accommodate any of the FIREBERD 1500A and 2000-compatible interfaces that are also used with the FIREBERD 6000. The ISU can be mounted with the interface facing the front of the rack (front access) or the rear of the rack (rear access). A BNC connector is mounted facing the front of the rack for the application of an external clock signal to the FIREBERD. The ISU can operate at 100/120/220/240 volts ac (50/60 Hz) and occupies 5 1/4" of rack height. For additional information on the ISU, refer to the ISU-2000 Operating Manual.

11.3.4 ISU Flush Door Accessory (Model 10518)

The Interface Switching unit can be equipped with an optional Flush Door Accessory. The accessory recesses the ISU panel approximately 4 1/2" behind the rack mount surface and provides a smoke gray plexiglass door. The unit conceals the interface modules and cables while still allowing access to the interface module front panels.

11.3.5 Interface Extender (Model 10770)

The Interface Extender is an accessory to all FIREBERD mainframes housed in a metal case. The Interface Extender, which allows front panel access to the data interface module and its controls, connects to the FIREBERD via a shielded ribbon cable attached to a special data interface (included). The Model 10770 Interface Extender mounts under the FIREBERD mainframe. A Rack Mount Adaptor (Model 10773) is available for mounting the Interface Extender in a standard 19" rack.

11.3.6 FIREBERD 6000/6000R Rack Mount (Model RM-6000)

The RM-6000 allows the standard FIREBERD 6000 (plastic case) or the FIREBERD 6000R and the PR-2000 Thermal Printer to be mounted in a standard 19" equipment rack. The assembly requires 7" of vertical rack space. The Rack Mount provides a power switch for the Thermal printer and an AC receptacle to provide ac power to both the FIREBERD and the PR-2000 Thermal Printer.

WARNING: To minimize shock hazard, the Rack Mount chassis must be connected to an electrical ground. The Rack Mount is equipped with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adaptor with grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

The following sections provide instructions for mounting the FIREBERD and the PR-2000 Printer in the RM-6000 Rack Mount. If the FIREBERD has a swing-around handle, it must be removed before mounting into the Rack Mount; the user may either return the FIREBERD to TTC for handle removal or use the following handle removal instructions. If the FIREBERD does not have a handle, proceed directly to the assembly instructions.

FIREBERD Handle Removal (All Metal, Black Side Arms and Cross Bar)

1. Disconnect the AC power cord from the FIREBERD.

2. Remove the left and right pushbutton and spring on each side (insert small screwdriver and pry gently). Remove the screw and washer from both sides. This will allow complete removal of handle and ratchet mechanism. The FIREBERD is now ready for rack mount assembly.

Assembly Instructions

1. Install the printer as follows:*

   a. Insert the PR-2000 through the Rack Mount Panel from the front.

   b. Unlatch and slide the printer mechanism forward, exposing the printer mounting ears. Install four #4 x 3/16" lg. pan head screws into the holes of the mounting ears, then return the printer mechanism to its operating position (closed).

   c. Install the printer support bracket at the rear of the printer by removing the two #3 screws at the top rear of the PR-2000. Attach the support bracket to the printer and chassis using four #4-40 x 3/16" lg. screws and lock washers.

2. Install FIREBERD as follows:

   a. Make sure the FIREBERD does not have the handle or side handle ratchet installed. The sides of the FIREBERD must be free of all handle components so that it will fit into the rack adaptor.

   b. Place the FIREBERD on the shelf, front panel facing forward, and carefully manipulate the front of the case through the opening. It should protrude through the front panel about 1/4 inch.

   c. Lift the rear of the FIREBERD and insert the two 1/4" hex x 3/16" 14. standoffs in the rear feet and align with two holes in the shelf. Install two #6 x 3/16" lg. screws and two lock washers through the bottom of the shelf into the stand-offs.

   d. Install the two "Z" hold-down brackets at the rear of the instrument using the #4 hardware provided with the rack adaptor.

   e. Plug the FIREBERD and the printer into the 115 VAC receptacle. The printer should be plugged into the receptacle that is controlled by the front-panel switch.

   f. Fold and store excess FIREBERD and printer line cord under the printer. The bracket is designed to allow cable storage.

3. Connect the cable supplied with the printer from the 25-pin "D" type connector on the rear of the printer to the RS-232 printer connector on the FIREBERD.

4. The RM-1500A unit should now be ready for rack installation. The unit will mount in a rack by its front panel without further angle brackets or supports.

*If a printer is not to be installed into the Rack Mount unit, a blank-off plate is available to cover the Printer Mounting hole.

11.3.7 FIREBERD MC6000 Rack Mount (Model RM-MC)

The RM-MC allows the FIREBERD MC6000 and the PR-2000 Thermal Printer to be mounted in a standard 19" equipment rack. This assembly requires 7" of vertical rack space. The Rack Mount provides a power switch for the Thermal Printer and an AC receptacle to provide ac power to both the FIREBERD and the PR-2000 Thermal Printer.

WARNING: To minimize shock hazard, the Rack Mount chassis must be connected to an electrical ground. The Rack Mount is equipped with a three-conductor AC power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three contact or two contact adaptor with grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet.

The following sections provide instructions for mounting the FIREBERD and the PR-2000 Printer in the RM-MC Rack Mount. If the FIREBERD has a swing-around handle, this handle must be removed before mounting into the Rack Mount, the user may either return the FIREBERD to TTC for handle removal or use the following handle removal instructions. If the FIREBERD does not have a handle, proceed directly to the assembly instructions.

FIREBERD Handle Removal (Metal Case Units)

1. Disconnect the AC power cord from the FIREBERD.

2. Remove the left and right push button and spring on each side (insert small screw driver and pry gently). Remove the screw and washer from both sides. This

will allow complete removal of handle and ratchet mechanism. The FIREBERD is now ready for rack mount assembly.

Assembly Instructions

1. Install the printer as follows*:

   a. Insert the PR-2000 through the Rack Mount Panel from the front.

   b. Unlatch and slide the printer mechanism forward, exposing the printer mounting ears. Install four #4 x 3/16S lg. pan head screws into the holes of the mounting ears then return the printer mechanism to its operating position (closed).

2. Install FIREBERD as follows:

   a. Make sure that the FIREBERD does not have the handle installed. The sides of the FIREBERD must be free of all handle components in order to fit into the rack adaptor.

   b. Place the FIREBERD on the shelf, front panel facing forward, and carefully manipulate the front of the case through the opening. It should protrude through the front panel until the lip of the bezel fits solidly.

   c. Install the two "Z" hold-down brackets at the rear of the instrument using the #4 hardware provided with the rack adaptor.

   d. Plug the FIREBERD and the printer into the AC receptacle. The printer should be plugged into the receptacle that is controlled by the front panel switch.

   e. Fold and store excess FIREBERD and printer line cord under the printer.

3. Connect the cable supplied with the printer from the 25-pin D connector on the rear of the printer to the RS-232 printer connector on the FIREBERD.

4. The RM-MC6000 unit should now be ready for rack installation. The unit will mount in a rack by its front panel without further angle brackets or supports.

*If a printer is not to be installed into the Rack Mount unit, a blank-off plate is available to cover the Printer Mounting hole.

11.3.8 Hard Shipping Case (Model 40527)

The rigid ABS molded case has a foam-padded interior with cavities to hold the FIREBERD MC6000 and its accessories. The case is rugged and water-resistant, and has stainless steel draw latches and a molded handle.

11.3.9 Soft Carrying Case (Model 41169)

The FIREBERD Soft Carrying Case is constructed of canvas with dense foam inserts surrounding all sides, top, and bottom. The dimensions are 19 1/2" wide x 9 1/2" deep x 16 1/8" high. The case is navy blue and has an I.D. pocket on the top cover. The top cover is hinged and secured with Velcro fasteners. The case is carried by a handle that supports across the bottom and up both sides. Additionally, there is a padded, adjustable, snap-on shoulder strap.

The carrying case holds one standard FIREBERD (plastic case), a PR-2000 Thermal Printer, one manual, and three interface modules in addition to the associated cables and line cords. The carrying case will also hold one FIREBERD MC6000 (metal case), one manual, two interface modules, and several cables. Empty, the case weighs 6 1/4 lbs.

11.3.10 PR-85 Soft Carrying Case

The PR-85 Soft Carrying Case is constructed of canvas with dense foam inserts surrounding all sides, top, and bottom. The dimensions of the case are 20" wide x 8 1/2" deep x 17 1/2" high. The top cover is hinged and secured with Velcro fasteners. The case is carried by a handle that supports the bottom and both sides of the case. The carrying case includes a backpouch used to hold the operating manual, printer paper, and printer cable. Empty, the case weighs 3 1/4 pounds.

11.3.11 ISU-6000 Interface Switching Unit

The ISU-6000 Interface Switching unit (ISU) is a rack-mountable product capable of accommodating multiple data interface modules and electronically setting one interface for use with the FIREBERD 6000. Using this device, the user can operate a FIREBERD 6000 without handling interfaces or moving cables. Switching between the installed interfaces is controlled by the FIREBERD 6000's Interface Setup menu.

Single-Unit Configuration (Four Interfaces)

The ISU-6000 may be configured to accommodate four or eight interfaces. The components for each configuration are listed on the following page:

- One Interface Shelf (Model 10805)
- One Single Cable Interface Adaptor (Model 40678)
- One Flush Door (Model 10518) (optional)

Dual-Unit Configuration (Eight Interfaces)

- Two Interface Shelves (Model 10805)
- One Dual Cable Interface Adaptor (Model 40681)
- Two Flush Doors (Model 10518) (optional)

11.4 ORDERING INFORMATION

The following is a list of accessories available from TTC at the time this manual was printed; model numbers are listed for ordering purposes. Contact TTC for an up-to-date list.

RACK MOUNTS

Rack Mount for FIREBERD 6000 (Plastic Case) and printer	RM-6000
Rack Mount for FIREBERD MC6000 and Printer	RM-MC6000
Rack Mount for FIREBERD 6000R	RM-6000

INTERFACE SWITCHING UNITS (ISU)

Interface Switching Unit (4 Interfaces)	ISU 6000-4
Interface Switching Unit (8 Interfaces)	ISU 6000-8
Interface Switching Unit Flush Door	10518
Interface Extender (for FIREBERD metal case)	10770
Rack Mount Adaptor for Interface Extender	10773

PRINTERS

PR-2000 Thermal Printer (20-column) with cable	PR-2000
PR-2000 Printer Paper (12 rolls)	10217
PR40A Thermal Graphics Printer	PR40A
PR40A Thermal Printer Paper (10 rolls)	10966
PR-85 ASCII and Graphics Printer (80-column) with cable	PR-85
PR-85 Soft Carrying Case	40522
PR-85 Printer Paper (2400 sheets)	10651
PR-85 Printer Replacement Ribbon	10653
PR-85 Printer Replacement Print Head	10671

MISCELLANEOUS

Replacement Operating Manual Set	ML10607
Replacement Telephone Handset with 12' cord	11255
Soft Carrying Case (for both FIREBERD plastic and metal case)	41169
Hard Shipping Case (for both FIREBERD plastic and metal case)	40572
Remote Adaptor (For RS-232 and IEEE-488 Remote Control)	30379
Transmit Line Build Out	10557

DATA INTERFACE MODULES

CCITT G.703 2048 kb/s Data Interface	40380
CCITT G.702 64 kb/s Codirectional Data Interface	40323
CCITT G.703 64 kb/s Data Interface	30608
CCITT G.703 8448 kb/s Data Interface	30524
CCITT G.704 2048 kb/s Data Interface	30609
DDS Local Loop Interface	41131
DDS DS0A/DS0B Data Interface	30678
DDS DS0/DS0A Data Interface	30481
T1/FT1 Data Interface	41440
DS1/T1/D4/ESF/SLC-96 Data Interface	40540

DATA INTERFACE MODULES (continued)

DS1/T1/D4 Data Interface	40405
DS1/T1 Data Interface (Unframed Only)	40365
DS1C/D2 Data Interface	30447A
ISDN S/T TE Data Interface	41075
LAB (TTL) Data Interface	40204
MIL188-114 Balanced Data Interface	40298
MIL188C/MIL118-114 Unbalanced Data Interface	40226
RS-232/V.24/MIL188C DTE/DCE Data Interface	40392
RS-232 Synchronous DTE/DCE Data Interface	40236
RS-232 Synchronous/Isochronous DTE Data Interface	40232
RS-449/MIL Data Interface	41400
RS-449 (422/423) DTE/DCE Data Interface	40200
V.35/306 DTE/DCE Data Interface	40202
WECO 303 Data Interface	40182

CABLES

RS-232/V.24 male-to-male cable (6')	10213
RS-232/V.24 male-to-male cable (10')	10418
V.35/306 male-to-male cable (6')	10214
V.35/306 male-to-male cable (10')	10419
RS-449/Military male-to-male cable (6')	10215
RS-449/Military male-to-male cable (10')	10417
WECO 310 plug to WECO 310 plug cable (10')	10420
WECO 310 plug to alligator clips cable (10')	10558
WECO 310 plug to bantam plug cable (4')	10599
WECO 310 plug to bantam plug cable (10')	10559
Dual bantam plug to 15-pin adaptor cable (10')	30503
Military male 37-pin D to male 25-pin D adaptor cable (6')	10496
Military male 37-pin D to female 25-pin Dadaptor cable (6')	10538
RS-449 DTE to X.21 DTE adaptor cable	10562
OIU adaptor cable, 9-pin, male-to-male	20309
Lenkurt/Siemens Panel Jack to Dual Bantam/9-pin male (20')	41515
Bantam plug to bantam plug cable	10615
Bantam plug to alligator clips (10')	10648
Bantam plug to 5-pin male, Wescom adaptor (14")	30518
Bantam plug (dual) to RJ45S (10')	40602
Bantam plug (dual) to RJ45C (10')	40601
RJ45 to RJ45 cable (14')	11266
RJ45 to alligator clips (10')	30837
Siemens 3-pin to Siemens 3-pin (6')	30687
Siemens 3-pin to bantam plug (6')	30761

BREAKOUT BOXES

Breakout Box for RS-232C, V.24/V.28, MIL-188C	Model 25
Breakout Box for V.35, Bell 306	Model 34
Breakout Box for RS-449,V.10/V.11, MIL-188-114	Model 37

SECTION 12
MAINTENANCE AND SERVICE

12.1 SECTION SUMMARY

This section contains information on maintenance and service for the FIREBERD 6000. Specifically, it includes steps to take should the user experience difficulty operating the FIREBERD, maintenance procedures for the fan screen, and a description of TTC's warranty and repair procedures.

12.2 MAINTENANCE

12.2.1 In Case of Difficulty

If the unit fails to operate and no front or rear panel indicators illuminate, check the following:

- AC power cord and AC supply
- AC fuse and fuse size

If some indicators light but the unit fails to operate with the built-in RS-232 interface, there are three checks that can be made: (1) determine whether the interface in use is the correct one for the desired application; (2) verify that the interface is properly inserted in the interface slot; or (3) insert another interface (suitable for the application) in the event that the original interface itself is not operating properly. Power to the FIREBERD should always be off before removing or inserting interface modules. The interface cable and connections to the FIREBERD should also be checked.

Follow the Self-Test Procedure in Section 2 as an aid to localizing the problem. If the unit cannot be made to operate properly, call the TTC Customer Service Department for applications assistance.

12.2.2 Fan Screen

A fan mounted on the rear panel of the FIREBERD allows proper cooling and ventilation of the internal components. The fan is always in operation while the FIREBERD itself is on; the fan cannot be operated independently. The fan is protected by a screen which is attached to the outside of the rear panel for easy maintenance. The screen should be checked and cleaned periodically to ensure proper cooling operation. Before removing the screen for cleaning, remove power to the FIREBERD and allow fan to stop. Remove the four screws which attach the screen to the rear panel. The screen may be cleaned with compressed air or, if necessary, with a cleaning solvent. Reattach the screen by replacing the four screws which hold it in place.

12.3 SERVICE

12.3.1 Warranty Policy

All equipment manufactured by Telecommunications Techniques Corporation (TTC) is warranted against defects in material and workmanship. This warranty applies only to the original purchaser and is non-transferable unless express written authorization of the warranty transfer is granted by TTC.

FIREBERD mainframes (Models 6000, MC6000, 6000R) will be repaired or replaced (at our option) at no charge for a period of three (3) years after shipment to the customer. Data interfaces, cables, breakout boxes, accessories, and all equipment other than FIREBERD mainframes will be repaired or replaced (at our option) at no charge for a period of one (1) year after shipment to the customer.

Liability under this warranty extends only to the replacement value of the equipment. This warranty is void under the following conditions:

1. Equipment has been altered or repaired without specific authorization by TTC.

2. Equipment is installed or operated other than in accordance with instructions contained in TTC literature and operating manuals.

No other warranty is expressed or implied. TTC is not liable for consequential damages.

12.3.2 In-Warranty Service

Equipment in warranty must be returned to the factory with shipping prepaid. The equipment should be packed and shipped in accordance with the instructions contained in Section 12.3.4 of this manual. Defective units will be repaired or replaced (at our option) depending on severity of defect. Before returning any equipment, the customer must obtain a Return Authorization (RA) number by contacting the TTC

Customer Service Department. The RA number should then appear on all paperwork and be clearly marked on the outside of the equipment container.

After the equipment is repaired by TTC, it will be tested to applicable specifications, burned-in for at least 24 hours, retested, and returned to the customer with shipping prepaid. A brief description of the work performed and the materials used will be provided on the Equipment Repair Report furnished with the returned equipment.

12.3.3 Out-of-Warranty Service

The procedure for repairing out-of-warranty equipment is the same as that used for equipment still in warranty. However, there is a minimum charge applied to each request for out-of-warranty service. The minimum charge guarantees the customer an estimate of the repair costs and is used as credit against actual materials and labor costs should the equipment be repaired. Contact the TTC Repair Department for specific information on the minimum out-of-warranty repair charge.

The customer will be billed for parts plus standard labor rates in effect at the time of repair. The customer will also be required to furnish a purchase order number before repair work can be started, and a hard copy of the purchase order must be received by TTC before the repaired equipment may be shipped to the customer. A description of the labor and materials used will be provided in the Equipment Repair Report.

12.3.4 Equipment Return Instructions

To all equipment returned for repair, the customer should attach a tag that includes the following information.

1. Owner's name and address.
2. A list of the equipment being returned and the applicable serial number(s).
3. A detailed description of the problem or service requested.
4. The name and telephone number of the person to contact regarding questions about the repair.
5. The Return Authorization (RA) number.

If a FIREBERD mainframe is being returned, it is recommended that all switches be left in the positions they were in when the problem occurred. The interface module in use at the time of the failure should also be returned.

If possible, the customer should return the equipment using the original shipping container and material. If the original container is not available, the unit should be carefully packed so that it will not be damaged in transit. TTC is not liable for any damage that may occur during shipping. The customer should clearly mark the TTC-issued RA number on the outside of the package and ship it prepaid and insured to TTC.

APPENDIX A
HEX CONVERSION TABLE

HEX	BAUDOT		BCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
00	Blank	Blank	Space	Space	NUL (Blank)	NUL (Null)
01	E	3	=	1	SOH (Start of Header)	SOH (Start of Header)
02	LF	LF	<	2	STX (Start of Text)	STX (Start of Text)
03	A		:	3	EXT (End of Text)	EXT (End of Text)
04	Space	Space	:	4	EOT (End of Transmission)	PF (Punch Off)
05	S	' or BELL	%	5	ENQ (Enquiry)	HT (Horizontal Tab)
06	I	8	'	6	ACK (Acknowledge)	LC (Lower Case)
07	U	7	>	7	BEL (Bell)	DEL (Delete)
08	CR	CR	*	8	BS (Backspace)	
09	D	WRU or $	(	9	HT (Horizontal Tabulation)	RLF
0A	R	4	)	0	LF (Line Feed)	SMM (Start Manual Message)
0B	J	BELL or '	"	#	VT (Vertical Tabulation)	VT (Vertical Tab)
0C	N	,	DC2	DC2	FF (Form Feed)	FF (Form Feed)
0D	F	!	RS	RS	CR (Carriage Return)	CR (Carriage Return)
0E	C	:	UPPER	UPPER	SO (Shift Out)	SO (Shift Out)
0F	K	(	EOT	EOT	SI (Shift In)	SI (Shift In)
10	T	5	CAN	@	DLE (Data Link Escape)	DLE (Data Link Escape)
11	Z	+ or "	?	/	DC1 (Device Control 1)	DC1 (Device Control 1)
12	L	)	S	s	DC2 (Device Control 2)	DC2 (Device Control 2)
13	W	2	T	t	DC3 (Device Control 3)	DC3 (Device Control 3)
14	H	#	U	u	DC4 (Device Control 4)	RES (Restore)
15	Y	6	V	v	NAK (Negative Acknowledge)	NL (New Line)
16	P	0	W	w	SYN (Synchronization)	BS (Backspace)
17	Q	1	X	x	ETB (End of Text Block)	IL (Idle)
18	O	9	Y	y	CAN (Cancel)	CAN (Cancel)
19	B	?	Z	z	EM (End of Medium)	EM (End of Medium)
1A	G	&			SUB (Substitute)	CC (Cursor Control)
1B	FIGS	FIGS	[	[	ESC (Escape)	CU1 (Customer Use 1)
1C	M	.	BEL	BEL	FS (File Separator)	IFS (Interchange File Sep.)
1D	X	/	LF	LF	GS (Group Separator)	IGS (Interchange Group Sep.)
1E	V	= or ;	ETB	ETB	RS (Record Separator)	IRS (Interchange Record Sep.)
1F	LTRS	LTRS	DC3	DC3	US (Unit Separator)	IUS (Interchange Unit Sep.)

HEX	BAUDOT		BCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
20	Blank	Blank		_	SP	DS (Digit Select)
21	E	3	J	j	!	SOS (Start of Significance)
22	LF	LF	K	k	"	FS (Field Separator)
23	A		L	l	#	
24	Space	Space	M	m	$	BYP (Bypass)
25	S	' or BELL	N	n	%	LF (Line Feed)
26	I	8	O	o	&	ETB (End Transmission Block)
27	U	7	P	p	' (Single Closing Quote)	ESC (Escape)
28	CR	CR	Q	q	(	
29	D	WRU or $	R	r	)	
2A	R	4			*	SM (Set Mode)
2B	J	BELL or '	!	$	+	CU2 (Customer Use 2)
2C	N	,	DC4	DC4	, (Comma)	
2D	F	'	CR	CR	- (Hyphen)	ENQ (Enquiry)
2E	C	.	BS	BS	. (Period)	ACK (Acknowledge)
2F	K	(	DLE	DLE	/	BEL (Bell)
30	T	5	+	&	0	
31	Z	+ or "	A	a	1	
32	L	)	B	b	2	SYN (Synchronous Idle)
33	W	2	C	c	3	
34	H	#	D	d	4	PN (Punch On)
35	Y	6	E	e	5	RS (Reader Stop)
36	P	0	F	f	6	UC (Upper Case)
37	Q	1	G	g	7	EOT (End of Transmission)
38	O	9	H	h	8	
39	B	?	I	i	9	
3A	G	&			:	
3B	FIGS	FIGS			;	CU3 (Customer Use 3)
3C	M		DC1	DC1	< (Less Than)	DC4 (Device Control 4)
3D	X	/	HT	HT	=	NAK (Negative Acknowledge)
3E	V	= or .	LOWER	LOWER	> (Greater Than)	
3F	LTRS	LTRS	DEL	DEL	?	SUB (Substitute)

HEX CONVERSION TABLE

HEX	BAUDOT		BCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
40	Blank	Blank	Space	Space	@	SP (Space)
41	E	3	=	1	A	
42	LF	LF	<	2	B	
43	A	-	:	3	C	
44	Space	Space	:	4	D	
45	S	' or BELL	%	5	E	
46	I	8	'	6	F	
47	U	7	>	7	G	
48	CR	CR	*	8	H	
49	D	WRU or $	(	9	I	
4A	R	4	)	0	J	¢
4B	J	BELL or '	"	#	K	. (Period)
4C	N	,	DC2	DC2	L	< (Less Than)
4D	F	!	RS	RS	M	(
4E	C	:	UPPER	UPPER	N	+
4F	K	(	EOT	EOT	O	| (Logical OR)
50	T	5	CAN	@	P	&
51	Z	+ or "	?	/	Q	
52	L	)	S	s	R	
53	W	2	T	t	S	
54	H	#	U	u	T	
55	Y	6	V	v	U	
56	P	0	W	w	V	
57	Q	1	X	x	W	
58	O	9	Y	y	X	
59	B	?	Z	z	Y	
5A	G	&			Z	!
5B	FIGS	FIGS	.	.	[(Opening Bracket)	$
5C	M	.	BEL	BEL	\ (Reverse Slant)	*
5D	X	/	LF	LF	] (Closing Bracket)	)
5E	V	= or ;	ETB	ETB	^ (Circumflex)	;
5F	LTRS	LTRS	DC3	DC3	_ (Underline)	¬ (Logical NOT)

HEX	BAUDOT		BCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
60	Blank	Blank			` (Opening Single Quote)	- (Hyphen)
61	E	3	J	j	a	/
62	LF	LF	K	k	b	
63	A	-	L	l	c	
64	Space	Space	M	m	d	
65	S	' or BELL	N	n	e	
66	I	8	O	o	f	
67	U	7	P	p	g	
68	CR	CR	Q	q	h	
69	D	WRU or $	R	r	i	
6A	R	4			j	| (Vertical Line)
6B	J	BELL or '	!	$	k	, (Comma)
6C	N	,	DC4	DC4	l	%
6D	F	!	CR	CR	m	_ (Underline)
6E	C	.	BS	BS	n	> (Greater Than)
6F	K	(	DLE	DLE	o	?
70	T	5	+	&	p	
71	Z	+ or "	A	a	q	
72	L	)	B	b	r	
73	W	2	C	c	s	
74	H	#	D	d	t	
75	Y	6	E	e	u	
76	P	0	F	f	v	
77	Q	1	G	g	w	
78	O	9	H	h	x	
79	B	?	I	i	y	` (Opening Quote)
7A	G	&			z	:
7B	FIGS	FIGS	.	.	{ (Opening Brace)	#
7C	M	.	DC1	DC1	| (Vertical Line)	@
7D	X	/	HT	HT	} (Closing Brace)	'
7E	V	= or ;	LOWER	LOWER	~ (Overline Tilde)	=
7F	LTRS	LTRS	DEL	DEL	DEL (Delete/Rubout)	"

HEX CONVERSION TABLE

HEX	BAUDOT		BCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
80	Blank	Blank	Space	Space	NUL (Blank)	
81	E	3	=	1	SOH (Start of Header)	a
82	LF	LF	<	2	STX (Start of Text)	b
83	A	—	:	3	EXT (End of Text)	c
84	Space	Space	:	4	EOT (End of Transmission)	d
85	S	; or BELL	%	5	ENQ (Enquiry)	e
86	I	8	`	6	ACK (Acknowledge)	f
87	U	7	>	7	BEL (Bell)	g
88	CR	CR	*	8	BS (Backspace)	h
89	D	WRU or $	(	9	HT (Horizontal Tabulation)	i
8A	R	4	)	0	LF (ne Feed)	
8B	J	BELL or '	"	#	VT (ertical Tabulation)	
8C	N	,	DC2	DC2	FF (Form Feed)	
8D	F	!	RS	RS	CR (Carriage Return)	
8E	C	:	UPPER	UPPER	SO (Shift Out)	
8F	K	(	EOT	EOT	SI (Shift In)	
90	T	5	CAN	@	DLE (Data Link Escape)	
91	Z	+ or "	?	/	DC1 (Device Control 1)	j
92	L	)	S	s	DC2 (Device Control 2)	k
93	W	2	T	t	DC3 (Device Control 3)	l
94	H	#	U	u	DC4 (Device Control 4)	m
95	Y	6	V	v	NAK (Negative Acknowledge)	n
96	P	0	W	w	SYN (Synchronization)	o
17	Q	1	X	x	ETB (End of Text Block)	p
98	O	9	Y	y	CAN (Cancel)	q
99	B	?	Z	z	EM (End of Medium)	r
9A	G	&			SUB (Substitute)	
9B	FIGS	FIGS	.	.	ESC (Escape)	
9C	M	.	BEL	BEL	FS (File Separator)	
9D	X	/	LF	LF	GS (Group Separator)	
9E	V	= or ;	ETB	ETB	RS (Record Separator)	
9F	LTRS	LTRS	DC3	DC3	US (Unit Separator)	

HEX	BAUDOT		BCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
A0	Blank	Blank		_	SP (Space)	
A1	E	3	J	j	!	~
A2	LF	LF	K	k	"	s
A3	A		L	l	#	t
A4	Space	Space	M	m	$	u
A5	S	' or BELL	N	n	%	v
A6	I	8	O	o	&	w
A7	U	7	P	p	' (Single Closing Quote)	x
A8	CR	CR	Q	q	(	y
A9	D	WRU or $	R	r	)	z
AA	R	4			*	
AB	J	BELL or '	'	$	+	
AC	N	,	DC4	DC4	, (Comma)	
AD	F	!	CR	CR	- (Hyphen)	
AE	C	.	BS	BS	. (Period)	
AF	K	(	DLE	DLE	/	
B0	T	5	+	&	0	
B1	Z	+ or "	A	a	1	
B2	L	)	B	b	2	
B3	W	2	C	c	3	
B4	H	#	D	d	4	
B5	Y	6	E	e	5	
B6	P	0	F	f	6	
B7	Q	1	G	g	7	
B8	O	9	H	h	8	
B9	B	?	I	i	9	
BA	G	&				
BB	FIGS	FIGS	.	.	.	
BC	M		DC1	DC1	< (Less Than)	
BD	X	/	HT	HT	=	
BE	V	= or ;	LOWER	LOWER	> (Greater Than)	
BF	LTRS	LTRS	DEL	DEL	?	

HEX CONVERSION TABLE

HEX	BAUDOT		BCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
C0	Blank	Blank	Space	Space	@	{
C1	E	3	=	1	A	A
C2	LF	LF	<	2	B	B
C3	A	-	:	3	C	C
C4	Space	Space	;	4	D	D
C5	S	' or BELL	%	5	E	E
C6	I	8	'	6	F	F
C7	U	7	>	7	G	G
C8	CR	CR	*	8	H	H
C9	D	WRU or $	(	9	I	I
CA	R	4	)	0	J	
CB	J	BELL or '	"	#	K	
CC	N	,	DC2	DC2	L	
CD	F	!	RS	RS	M	
CE	C	:	UPPER	UPPER	N	
CF	K	(	EOT	EOT	O	
D0	T	5	CAN	@	P	}
D1	Z	+ or "	?	/	Q	J
D2	L	)	S	s	R	K
D3	W	2	T	t	S	L
D4	H	#	U	u	T	M
D5	Y	6	V	v	U	N
D6	P	0	W	w	V	O
D7	Q	1	X	x	W	P
D8	O	9	Y	y	X	Q
D9	B	?	Z	z	Y	R
DA	G	&			Z	
DB	FIGS	FIGS	[	[	[(Opening Bracket)	
DC	M	.	BEL	BEL	\ (Reverse Slant)	
DD	X	/	LF	LF	] (Closing Bracket)	
DE	V	= or ;	ETB	ETB	^ (Circumflex)	
DF	LTRS	LTRS	DC3	DC3	_ (Underline)	

HEX			BCDIC		ASCII	EBCDIC
	LTRS	FIGS	UPPER	LOWER		
E0	Blank	Blank	-	_	` (Opening Single Quote)	/ (Reverse Slash)
E1	E	3	J	j	a	
E2	LF	LF	K	k	b	S
E3	A	-	L	l	c	T
E4	Space	Space	M	m	d	U
E5	S	; or BELL	N	n	e	V
E6	I	8	O	o	f	W
E7	U	7	P	p	g	X
E8	CR	CR	Q	q	h	Y
E9	D	WRU or $	R	r	i	Z
EA	R	4			j	
EB	J	BELL or '	!	$	k	
EC	N	,	DC4	DC4	l	
ED	F	!	CR	CR	m	_ (Underline)
EE	C	:	BS	BS	n	
EF	K	(	DLE	DLE	o	
F0	T	5	+	&	p	0
F1	Z	+ or "	A	a	q	1
F2	L	)	B	b	r	2
F3	W	2	C	c	s	3
F4	H	#	D	d	t	4
F5	Y	6	E	e	u	5
F6	P	0	F	f	v	6
F7	Q	1	G	g	w	7
F8	O	9	H	h	x	8
F9	B	?	I	i	y	9
FA	G	&			z	
FB	FIGS	FIGS	.		{ (Opening Brace)	
FC	M		DC1	DC1	| (Vertical Line)	
FD	X	/	HT	HT	} (Closing Brace)	
FE	V	= or .	LOWER	LOWER	~ (Overline Tilde)	
FF	LTRS	LTRS	DEL	DEL	DEL (Delete/Rubout)	

APPENDIX B

DISCUSSION OF G.821

This appendix discusses the concept of available time versus unavailable time as specified in CCITT Recommendation G.821. This discussion is provided to familiarize users with the results that are provided in the Performance category.

CCITT Recommendation G.821 defines available and unavailable time as follows:

> "A period of unavailable time begins when the bit error rate (BER) in each second is worse than 10^{-3} for a period of 10 consecutive seconds. These 10 seconds are considered to be unavailable time. The period of unavailable time terminates when the BER in each second is better than 10^{-3} for a period of 10 consecutive seconds. These 10 seconds are considered to be available time."

Available and unavailable time are measured in seconds–available seconds and unavailable seconds, respectively. All seconds after initial pattern synchronization must fall into one of the two categories (total available seconds + total unavailable seconds = total seconds after initial pattern synchronization.)

After initial pattern synchronization, seconds are considered to be available time; the available seconds begin counting (seconds before initial pattern synchronization are not included in performance analysis). These seconds continue to be counted until 10 consecutive seconds, each with a BER worse than 10^{-3}, occur. A sliding window, 10 seconds in length, is used to detect this transition from available time and vice versa.

As an example, assume a test begins and continues to run for 25 seconds and each of those 25 seconds has a BER better than or equal to 10^{-3}. After initial pattern synchronization, seconds are considered to be available time, so the available seconds count at this point is 25. In the 26th second, the BER becomes worse than 10^{-3}. The same for the 27th and 28th seconds. In the 29th second, the BER drops back to better than or equal to 10. All 29 seconds are a part of available time and are, therefore, counted as available seconds.

Even though there were 3 consecutive seconds (the 26th, 27th, and 28th) which each had a BER worse than 10^{-3}, 10 such consecutive seconds are required to make the transition to unavailable time. Those 3 individual seconds are still in available time and they are counted as available seconds.

The 3 seconds with a BER worse than 10^{-3} are also included in the count of severely errored seconds, which are those seconds with a BER worse than 10-3 that occur in available time. A signal loss second or a second in which pattern synchronization is lost is also considered to be a second with a BER worse than 10^{-3}. Therefore, the current test result values for available seconds count=29; the severely errored seconds (SES) count = 3, and the unavailable seconds count = 0.

The same test continues to run and remains in available time. In the 80th second, the BER for that second is worse than 10^{-3}. The BER for the 81st, 82nd, 83rd, 84th, and 85th seconds is also worse than 10^{-3}. In the 86th second, pattern synchronization is lost. This also continues for the 87th and 88th seconds. We now have 9 consecutive seconds each of which has a BER worse than 10^{-3}. As each of these seconds occurs, we are still in available time, so they are counted as available seconds and severely errored seconds. The transition has not been made from available time to unavailable time.

sec 20 BER <=	sec 21 BER <=	sec 22 BER <=	sec 23 BER <=	sec 24 BER <=	sec 25 BER <=	sec 26 BER >	sec 27 BER >	sec 28 BER >	sec 29 BER <=

Sliding Window After 29th Test Second
Still in Available Time

sec 79 BER	sec 80 BER	sec 81 BER	sec 82 BER	sec 83 BER	sec 84 BER	sec 85 BER	sec 86 BER	sec 87 BER	sec 88 BER
<=	>	>	>	>	>	>	>	>	>

Sliding Window After 88th Test Second
Still in Available Time

The 89th second also has a BER worse than 10^{-3}. At this point. the available seconds count = 89, the SES count = 13, and the unavailable seconds count = 0. However, the sliding window now contains 10 consecutive seconds each of which has a BER worse than 10-3. A transition is made to unavailable time. able time, all seconds are counted as unavailable seconds until 10 consecutive seconds occur each with a BER better than 10^{-3}. As the sample test continues, the 90th through 150th seconds each have a BER worse than or equal to 10^{-3}. We are still in unavailable time, so these seconds are counted as

sec 80 BER	sec 81 BER	sec 82 BER	sec 83 BER	sec 84 BER	sec 85 BER	sec 86 BER	sec 87 BER	sec 88 BER	sec 89 BER
>	>	>	>	>	>	>	>	>	>

Sliding Window After 89th Test Second
Transition to unavailable Time

Those 10 seconds which had been counted as available seconds are deducted from the available seconds count and are added to the unavailable seconds count; the available seconds count becomes 79, and the unavailable seconds count becomes 10. Those same 10 seconds were also included in the SES count. However, SES is limited to only those seconds in available time which have a BER worse than 10^{-3}; therefore, those last consecutive 10 seconds must also be deducted from the SES count (the SES count is updated to 3).

Once the transition occurs from available time to unavailunavailable seconds; now the total available seconds count = 79 and the total unavailable seconds count = 7l.

Beginning with the 151st second, the BER for that second falls below 10^{-3} It is still counted as an unavailable second since we are still in unavailable time and the transition has not been made to available time. A BER better than 10^{-3} also occurs for the 152nd, 153rd, 154th, 155th, 156th, 157th, 158th, 159th, and 160th seconds. Since there are now 10 consecutive seconds with a BER better than 10^{-3}, the transition is made from unavailable time to available time.

sec 151 BER <	sec 152 BER <	sec 153 BER <	sec 154 BER <	sec 155 BER <	sec 156 BER <	sec 157 BER <	sec 158 BER <	sec 159 BER <	sec 160 BER <

Sliding Window After 160th Test Second
Transition to Available Time

As each of these 10 seconds occurred, it was added to the unavailable seconds count (unavailable seconds = 81, available seconds = 79, and SES = 3). Now that those consecutive seconds have triggered the transition to available time, they are deducted from the unavailable seconds count and added to the available seconds count. Now the unavailable seconds count = 71 and the available seconds count = 89.

The monitoring of available and unavailable time continues for the duration of the test.

Degraded minutes is an error analysis result that is affected by available and unavailable time. Degraded minutes is a count of the number of minutes during which an average BER worse than 10^{-6} occurs. The 1-minute intervals are derived by removing unavailable seconds and severely errored seconds (SES) from the total test time and then consecutively grouping the remaining seconds into blocks of 60. The average BER is calculated for the block of 60 seconds and, if it is worse than 10^{-6}, the block is counted as a degraded minute.

In the transition from available time to unavailable time. the degraded minutes result is unaffected. This is because a switch to unavailable time requires 10 consecutive seconds each with a BER worse than 10^{-3}. Any second in available time with a BER worse than 10^{-3} is considered to be a severely errored second and, therefore, not included in the accumulation of seconds used to calculate degraded minutes.

Moving from unavailable time to available time may affect the degraded minutes count. While in unavailable time, 10 consecutive seconds each with a BER better than 10^{-3} are required for the transition to available time. Then this happens, those 10 seconds are subtracted from the unavailable seconds count and are added to the available seconds count. Since these seconds are now considered to be a part of available time and they are not severely errored seconds, they are included in the calculation of degraded minutes.

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